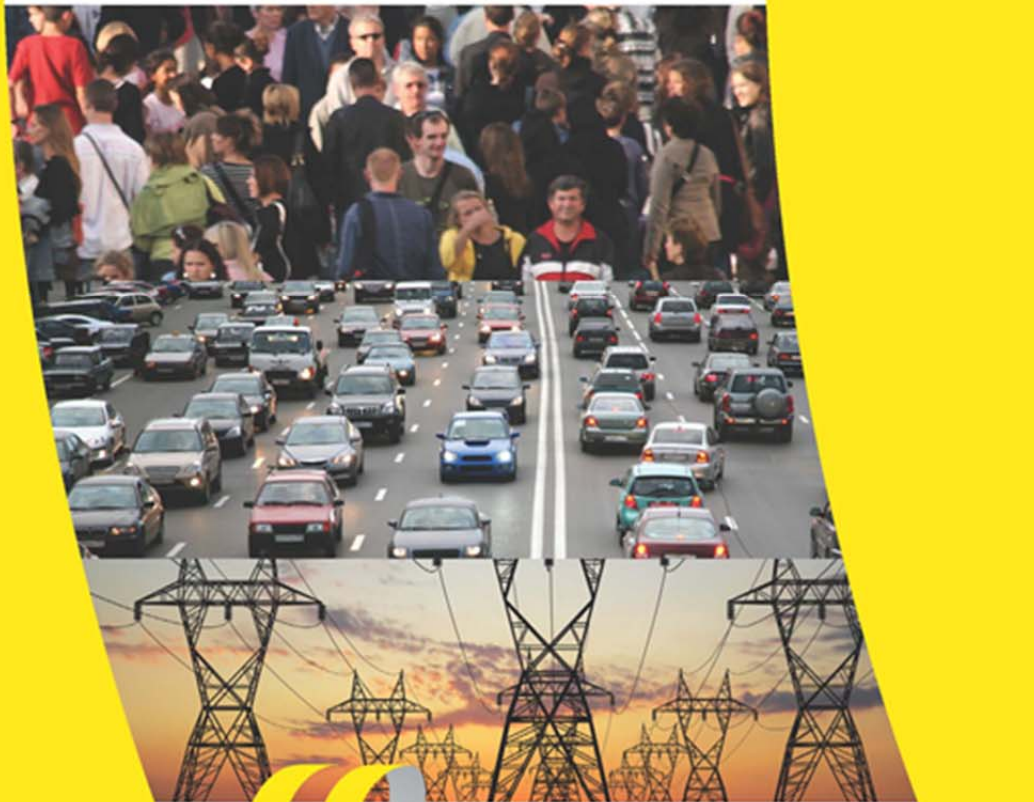
Road taxation and spending in the EU



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Road taxation and spending in the EU

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Content

Summary

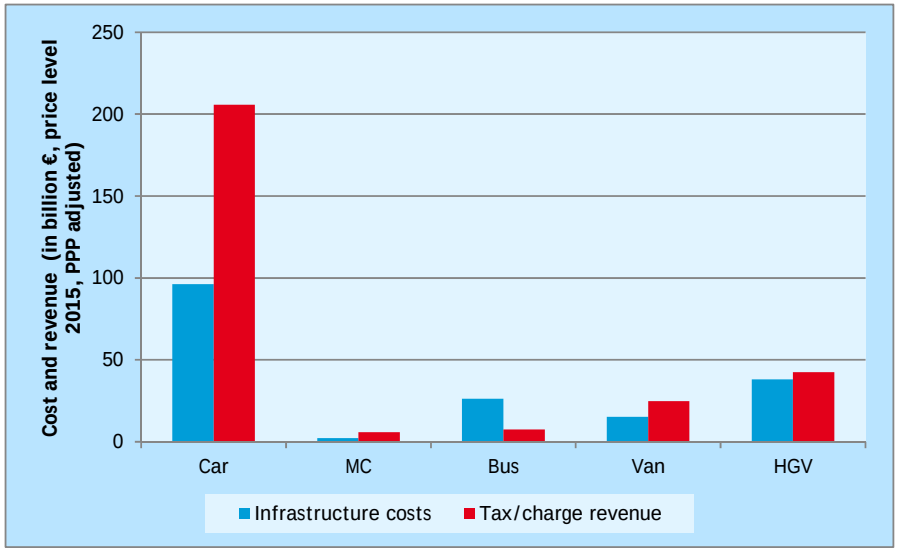
National and local governments spend a significant amount of their budgets in building and maintaining the road infrastructure network. The exact amount, however, is not common knowledge nor is the revenue that is being collected from road transport. With the European Commission intending to revise the Eurovignette Directive[1], CE Delft, on behalf of FIA Region I, has examined how much is being invested by the EU27 Member States[2] into road networks versus the revenue that is being collected from transport taxes and charges. The examination includes the revenue coming from cars, motorcycles, vans, busses and heavy goods vehicles (HGVs).

Costs versus revenue

Revenue from taxes and charges on road transport exceeds the infrastructure costs in the EU.

The revenue from specific road transport taxes and charges (€ 286 billion) exceeds the infrastructure cost (€ 178 billion) in 2013 in the EU. In only a few countries (Croatia, Hungary and Romania) this was not the case, which is mainly because these countries have spent very large amounts in upgrading their road infrastructure network over the last two decades.

Figure 1 Infrastructure cost and revenue from specific transport taxes/charges per mode of transport in 2013



As is shown in Figure 1, the tax/charge revenues from light vehicles (i.e. cars, motorcycles, vans) considerably exceed the cost they inflict to road infrastructure. For buses, on the other hand, tax/charge revenue is significantly lower than the infrastructure cost throughout the EU. Due to their higher mass, these vehicles inflict relatively more damage to roads than light vehicles, while at the same time these vehicles are less heavily taxed. At the EU level, revenue and cost are almost equal for HGVs, although large differences exist between countries. In some countries (e.g. Germany,

1 Directive providing a framework for HGV road charging schemes that must be followed by Member States who wish to apply those schemes. The revision of this Directive may include an extension of the Directive's scope to other vehicles, such as passenger cars.

2 Because of a lack of reliable data on road infrastructure spending, Cyprus is not covered in this assessment.

Sweden, UK) the tax/charge revenue significantly exceed infrastructure cost, while in countries (e.g. The Netherlands, Romania, Hungary) revenue are only 50% of the cost.

Revenues from taxes and charges

Revenue from specific road taxes and charges in 2013 in the EU27 is € 286 billion

The revenue that was collected from specific transport taxes (registration tax (incl. VAT), ownership tax, fuel excise duties (incl. VAT), and road infrastructure charges) in 2013 in the EU27 came to a total of € 286 billion. Additionally, the revenue from VAT on vehicles and transport fuels is about € 79 billion. When the revenue was broken down by vehicle type, it was seen that cars contribute 71% of the total, due to the large volume of cars driving on the roads and the relatively high overall tax/charge levels for passenger cars (compared to other modes of transportation).

When looked at as a proportion of the national tax budget, income from specific road transport taxes/charges came to 5-10% of total tax revenue. Significant differences between countries do exist: in Slovenia, road transport contributed as much as 14% of the total national tax income, while in Sweden it was only 4%.

Infrastructure costs

EU road transport infrastructure costs are approximately € 178 billion in 2013

For this study, road infrastructure cost include investments in new infrastructure and renewal of existing roads; expenditure on maintenance of existing roads; and operational expenditure enabling use of the road network (e.g. lighting). From the total infrastructure cost of € 178 billion, about half (54%) can be allocated to passenger cars. The highest cost per kilometre are found for busses and HGVs, because these heavier vehicles inflict more damage to road infrastructure.

Development infrastructure spending over time

Road infrastructure expenditures seriously affected by economic crisis

This study also examined long term trends in road infrastructure spending by governments from 1995-2013 and found that investments has been decreasing, especially since the beginning of the economic crisis. Particularly in Southern (e.g. Portugal, Spain, Italy) and Eastern (e.g. Poland, Hungary, Lithuania) European countries, budgets for investments in new infrastructure and maintenance of existing roads have been cut. There are, on the other hand, also a few countries where budgets have been increased to stimulate economic growth (e.g. France).

The crisis has, among other things, put a stop to the increase in infrastructure spending in early 2000 in Central and Eastern European countries. The trend towards increase in that period was a response to the rising need for improvement of road networks in order to facilitate economic development in those countries. Access to large-scale EU funds for road infrastructure investments has contributed to this trend as well.

Robustness of results

This study's results contain some uncertainties, which has to be kept in mind when interpreting them. Nevertheless, the data presented reflects at least the right order of magnitude for the costs and revenue that are considered. However, direct comparisons between countries should be made carefully, since data availability and quality vary significantly between countries. Trend data (e.g. development of infrastructure spending in the period 1995-2013) for individual countries and groups of countries (e.g. Western European countries) is relatively consistent over time, and the identification of trends for these countries is considered to be reliable.

Glossary

Term	Explanation
$€_{2013}$	Euros expressed in price level 2013.
Bus	Passenger road motor vehicle designed to carry more than 24 persons (including the driver), and with provision to carry seated as well as standing passengers (ITF et al., 2009). In this study mini-busses (passenger road motor vehicle designed to carry 10-23 seated or standing persons) and coaches (see: Coach) are considered as busses as well.
CEEC	Central and Eastern European Countries, including: Bulgaria, Czech Republic, Estonia, Croatia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia; all Member States of the European Union, as distinguished from Western European Countries.
Coach	Passenger road motor vehicle designed to seat 24 or more persons (including the driver) and constructed exclusively for the carriage of seated passengers (ITF et al., 2009).
Charges	Compulsory requited payments, where requited means that the payer does receive anything directly in return.
Consumer Price Index (CPI)	Consumer Price Index; indicator measuring the weighted average of prices in a predetermined basket of goods. Changes in this indicator are used to correct monetarised data for inflation.
Enhancement costs/expenditures	All costs/expenditures of new infrastructure or expansion of existing infrastructure with respect to functionality and/or lifetime.
EU27	All 28 EU Member States except Cyprus.
Excise duty	Excise duties are indirect taxes (see: Tax) on the sale or use of specific products. For example, fuel excise duties are taxes on the sale of (motor) fuels.
Expenditures (on infrastructure)	The actual amounts of money extracted annually from the public (or private) accounts to finance infrastructure. Infrastructure expenditures do not include financing costs.
External costs	Unintended costs imposed on third parties for which no compensation is received. Important types of external costs of transport are: air pollution, climate change, noise, accidents and congestion.
Fixed costs	Costs that do not vary with transport volume while the functionality of the infrastructure remains unchanged, or costs that enhance the functionality of the infrastructure.
Foreign vehicle	A vehicle registered in a country other than the reporting country and bearing registration plates of that foreign country.
Gross Domestic Product (GDP)	Aggregate measure of production equal to the sum of the gross value added of all resident, institutional units engaged in production.
Heavy Goods Vehicle (HGV)	Goods road vehicle with a gross vehicle weight above 3,500 kg, designed, exclusively or primarily, to carry goods.
Infrastructure costs	The direct expenses on infrastructure plus the financing costs or – regarded from a different point of view – the opportunity costs for not spending the resources for more profitable purposes.
Infrastructure cost coverage ratio	Ratio reflecting the share of infrastructure costs covered by tax/charge revenue.
Investment (expenditure)	Expenditures on the enhancement (see: Enhancement costs/expenditures) and the renewal (see: Renewal costs/expenditures) of the infrastructure network.

Term	Explanation
Load	Weight of the goods transported by a vehicle.
Maintenance costs/expenditures	Costs/expenditures referring to the costs/expenditures of/for 'ordinary' maintenance. These are relatively minor repairs with an economic lifetime of less than 1 to 2 years.
Motorcycle (MC)	Two-, three- or four-wheeled road motor vehicle not exceeding 400 kg (900 lb) of unladen weight. All such vehicles with a cylinder capacity of 50 cc or over are included.
National vehicle	A vehicle registered in the reporting country and bearing registration plates of that country or having been separately registered.
Operation costs/ expenditures	These costs/expenditures refer to the costs/expenditures of the organisation of efficient use of the infrastructure.
Operation and Maintenance (O&M) costs/expenditures	The sum of operation (see: Operation costs/expenditures) and maintenance (see: Maintenance expenditures/costs).
Ownership tax	Periodical tax levied on the ownership of a vehicle. Often referred to as circulation tax.
Passenger car	Road motor vehicle, other than a moped or a motorcycle, intended for the carriage of passengers and designed to seat no more than nine persons (including the driver).
Passenger car equivalent (PCE)	Indicator measuring the impact that a single vehicle has on traffic variables (e.g. speed, density) compared to a single car.
Passenger kilometre (pkm)	Unit of measurement representing the transport of one passenger by road over one kilometre.
Paved road	Road surfaced with crushed stone (macadam) with hydrocarbon binder or bituminized agents, with concrete or with cobblestone.
Perpetual Inventory Method (PIM)	Method to estimate infrastructure costs based on time series data on infrastructure expenditures. To estimate the enhancement (see: Enhancement costs/expenditures) and renewal (see: Renewal costs/expenditures) costs, this method first calculates the annual depreciation costs by distributing the initial investment over the lifetime of the infrastructure. In addition to the depreciation costs, interest costs are estimated by using an appropriate interest rate. The sum of depreciation and interest costs equals enhancement and/or renewal costs. O&M costs (see: O&M costs/expenditures) are not capitalised in the PIM, but running costs are taken into account instead.
Purchasing Power Parity (PPP)	Indicator reflecting the purchasing power of countries. This indicator is used to correct monetarised figures for differences in purchasing power of a euro across countries.
Registration tax	Taxes levied on the (first) registration of a vehicle in a country. Registration fees are not included, as these are direct payments for actual activities carried out (i.e. registering vehicles).
Renewal costs/expenditures	All costs/expenditures associated with the renewal of (parts of) the infrastructure. The renewed (parts of) the infrastructure will at least have a lifetime of more than 1-2 years. Renewal costs/expenditures do include extraordinary maintenance with a lifespan of more than 1-2 years.
Road	Line of communication (travelled way) open to public traffic, primarily for the use of road motor vehicles, using a stabilised base other than rails or air strips.
Road network	All roads in a given area.
Road network length	The length of all roads in a given area.
Road traffic on national territory	Any movement of road vehicles within a national territory irrespective of the country in which these vehicles are registered.

Term	Explanation
Southern European Countries	Group of countries, including: Greece, Italy, Portugal, and Spain.
Steady state level expenditure	Expenditures related to the minimum package of maintenance (and operational) measures required to ensure the long-term physical and functional integrity of existing infrastructure under current conditions.
Subsidy	Fiscal supports with direct relevance to public budgets and with no direct service in return.
Tax	Compulsory unrequited payments, where unrequited means that the payer does not receive anything directly in return.
Tonne kilometre (vkm)	Unit of measurement of goods transport which represents the transport of one tonne over one kilometre.
Unpaved road	Road with a stabilised base not surfaced with crushed stone, hydrocarbon binder or bituminised agents, concrete or cobblestone.
Value added tax (VAT)	Indirect tax (see: Tax) on the domestic consumption of goods and services. VAT is imposed on the added value at each stage of production. Producers are VAT-registered and they are entitled to deduct from the VAT amount the VAT paid on his or her purchases. For the final consumer, not being VAT-registered, VAT is a tax on the consumption of a good or service.
Van	Four-wheeled Goods road motor vehicle with a gross vehicle weight of not more than 3,500 kg.
Variable costs	Costs that vary with transport volumes while the functionality of the infrastructure remains unchanged.
Vehicle kilometre (vkm)	Unit of measurement representing the movement of a vehicle over one kilometre.
WEC	Western European Countries, including: Austria, Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, The Netherlands, Portugal, Spain, Sweden, UK; all Member States of the European Union, as distinguished from Central and Eastern European Countries. Since for Cyprus only part of the data was available, it has not been included in this group of countries in this study.

Country abbreviations

Abbreviation	Country
AT	Austria
BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LV	Latvia
LT	Lithuania
LU	Luxembourg
MT	Malta
NL	The Netherlands
PO	Poland
PT	Portugal
RO	Romania
SK	Slovakia
SI	Slovenia
ES	Spain
SE	Sweden
UK	United Kingdom

1 Introduction

1.1 Background

Transport is part of any society and has a clear impact on citizens' lifestyle, location of activities and possibilities for consumption. Developments in transport, such as the increase in average speed with which items and services can be delivered, have led to fundamental changes in the way in which societies are organised. These developments are often regarded as an important driver of economic growth.

An efficient transport system requires a functional and well-maintained infrastructure. Significant parts of public budgets are dedicated to infrastructure investment, both to build new roads and to maintain and operate existing ones. On the other hand, governments levy several taxes and charges on the possession and use of vehicles, resulting in considerable amounts of revenue. As EU-wide information on these costs and revenue is limited, the current balance between infrastructure costs and revenue from transport taxes and charges is unknown.

This study aims to fill this knowledge gap, by studying the infrastructure costs and tax/charge revenue from road transport in the EU. Comparing costs and revenue will allow us to assess whether the road sector is a net contributor to the national budgets.

1.2 Objective and research questions

The objective of this study is:

- to provide an overview of the revenue of road taxes and charges, and the road infrastructure expenditures and costs in the EU in 2013;
- to make (graphical) comparisons of the tax/charges revenue and infrastructure costs of road transport for the EU countries, differentiating between different vehicle types.

In order to achieve this objective, the following research questions are addressed in this study:

1. What is the amount of road tax/charge revenue in 2013 in the EU Member States?
   a. What road taxes/charges are applied in the various EU Member States?
   b. What is the total revenue from these taxes/charges in 2013 for every EU Member State?
   c. What share do the various vehicle categories have in the total tax/charge revenue?

2. What is the amount of the expenditure on road infrastructure in 2013 in the EU Member States?
   a Which expenditures on road infrastructure should be considered?
   b What has been the size of these different categories of road expenditures in 2013 and over time (1995-2013)?
   c Are there significant differences between EU Member States with respect to these expenditures and how can these differences be explained?
3. What are the road infrastructure costs in 2013 in the EU Member States?
   a How are infrastructure costs estimated based on expenditure data?
   b What is the total amount of road infrastructure costs in 2013 in the EU? How can main differences between Member States be explained?
   c Which share do the various vehicle categories have in the total infrastructure costs?
4. How are the total tax revenue compared to the total infrastructure costs in 2013 in the EU Member States?
   a From what perspectives can tax revenue and infrastructure costs be compared?
   b What are the infrastructure cost coverage ratios in 2013 in the various EU countries?

1.3 Scope of the study

In this study, the following basic principles are applied:

- In this report, we present the total infrastructure costs and total revenue from taxes and charges[3] (see Sections 4.2 and 2.2 for more information on the scope applied for these two concepts respectively). Additionally, we present average figures, expressed in € per passenger kilometre for passenger modes, € per tonne kilometre for Heavy Goods Vehicles (HGVs), and € per vehicle kilometre for vans.
- Geographical scope: the study covers the EU28[4]. The road infrastructure expenditure data for Cyprus, however, did not allow to include it in the overviews. Therefore, for Cyprus only data on tax/charge revenue are presented in Chapter 2.
- All data is presented for the year 2013 for tax/charge revenue and infrastructure costs, as this is the most recent year for which all required data is available. Infrastructure expenditure data covers the period 1995–2012.
- All financial data is shown in euro price levels of 2013. Data from sources where price levels from other years were used, were translated to price level 2013 by Consumer Price Indices (CPI) for the specific countries. All financial figures were adjusted for differences in price level to allow comparison between countries. The consequences of these corrections are discussed in the textbox below.
- This study distinguishes between the following vehicle categories:
  - passenger car;
  - motorcycle (MC);

[3] Taxes are compulsory unrequited payments, where unrequited means that the payer does not receive anything directly in return. Charges, on the other hand, are requited payments in that they include the delivery of a service in exchange for a payment. For example, infrastructure charges are payments made for vehicles to use specific parts of the road infrastructure.

[4] Although Croatia joined the EU in the middle of 2013 (1 July 2013), we have included it in this study.

    - bus (also includes coaches and mini-busses)[5];
    - van;
    - heavy goods vehicles (HGV).
- We present both infrastructure expenditure and cost data. Expenditure data shows the impact of transport infrastructure on public accounts. Costs are preferred for the comparison between tax/charge revenue and infrastructure costs (see also Section 3.2).
- Transport subsidies are not covered by this study, with the exception of EU subsidies/loans for infrastructure investments and maintenance (e.g. Cohesion funding). These subsidies are (implicitly) part of the infrastructure expenditures (and hence costs) discussed in Chapter 3 (and 4).
- External costs of road transport are not covered in this study.
- All data is gathered from national and international data sources, including data from statistical offices, public accounts and other data sources on a national level. No primary data gathering on the level of lower governments such as provinces or communities has taken place.

Interpretation of results adjusted for price level variations between countries

European countries differ with respect to price levels; e.g. prices in Romania are significantly lower than in Germany. This implies that the purchasing power of one euro is larger in Romania than it is in Germany. In other words, you can buy more for one euro in Romania than you can in Germany. These differences in purchasing power also affect the comparison of infrastructure spending (and tax/charge revenue) between European countries. An investment of € 1 million in roads in Romania is much larger (in terms of domestic purchasing power) than the same investment in Germany. To make a fair comparison between countries, financial figures have to be corrected for the differences in purchasing power between countries. This can be done by applying Purchasing Power Parities (PPPs), which are indicators that reflect the differences in purchasing power between countries (by benchmarking them to the EU28 average price level). Applying such corrections would imply that the size of financial figures for countries with relatively low price levels (like Romania) will increase, while the size of financial figures for countries with relatively high price levels (like Germany) will decrease.

In this study all financial figures have been corrected with PPP-indicators from Eurostat. This implies that all PPP corrected financial figures (i.e. Infrastructure costs/expenditures, tax/charge revenue) for individual countries are shown for the EU28 average price level. Summing up these figures for all European countries provide total figures for the EU, expressed in the EU28 average price level.

PPP-adjusted figures cannot be compared directly with figures in national accounts, national statistics or national studies. This should be kept in mind when comparing the results of this study to results/figures from other sources.

1.4 Methodological approach and uncertainties

This study consists of three phases:

1. *Data gathering*; in this phase we collected data on revenue from road transport taxes and charges and road infrastructure expenditure. More general data (vehicle kilometres (vkm), passenger kilometres (pkm), tonne kilometres (tkm), road network length, Gross Domestic Product

[5] We were not able to distinguish between busses and coaches in our analyses, as this distinction is not made in many transport statistics (e.g. vehicle kilometer data is often only available for busses and coaches together).

(GDP), exchange rates, inflation rates, etc.) was collected as well. Several methodologies have been applied to gather all these data:

- Case studies: for eleven countries (Austria, Czech Republic, Denmark, Germany, France, Italy, The Netherlands, Poland, Spain, Sweden and the UK) an in-depth search for infrastructure expenditure data has been carried out by national experts[6]. These case studies provided detailed data that was used to further detail the infrastructure expenditure data for other countries. For more information on the case studies, see Annex B.
- Assessment of EU-wide statistical databases (mainly Eurostat, ITF and OECD) and reports (e.g. EU pocketbook).
- Assessment of national statistical databases (mainly from national statistical agencies) and reports.
- National representatives of Finance Ministries, Transport Ministries, road authorities, road charging scheme operators, and statistical agencies were requested to provide specific data (mainly to fill in data gaps).

2. *Data processing*; in this phase we first checked the reliability of the data (e.g. by crosschecking them with data from other sources) and missing data was estimated (see Annex A for more details). Next, infrastructure costs were estimated based on the infrastructure expenditure data gathered (see Section 4.2 for a detailed description of the methodology used to estimate the infrastructure costs). Finally, infrastructure cost coverage ratios were estimated by combining the data on tax/charge revenue and the estimated infrastructure costs.
3. *Data analysis and interpretation*; The data on tax/charge revenue, infrastructure expenditures/costs and infrastructure cost coverage ratios was analysed by means of graphical overviews and comparisons.
   The results were interpreted to form conclusions.

Data reliability

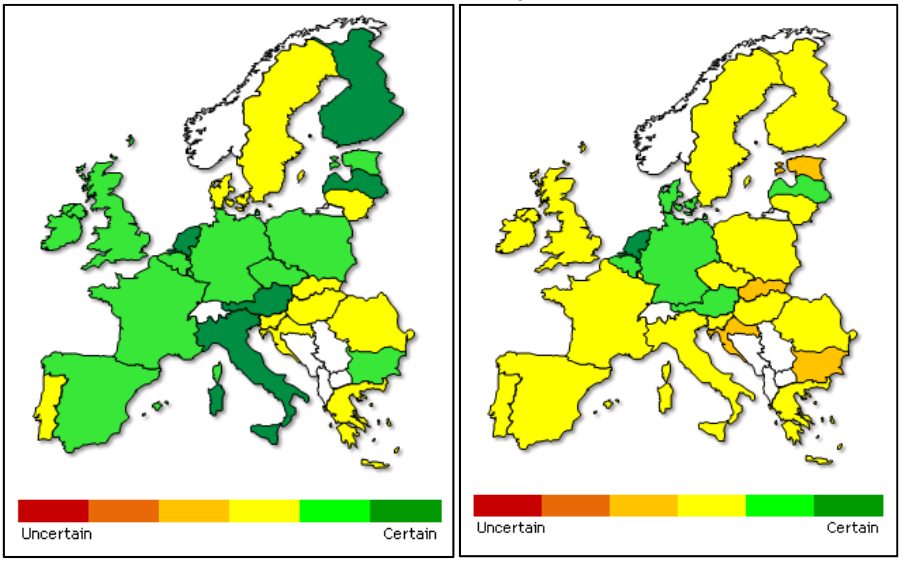
The results provided by this study are based on a lot of data, from different sources and of varying quality. Therefore, it is important to carefully consider the reliability of the data used in this report and the impact any uncertainties have on the results presented. In Annex A the reliability of the data used in this report is discussed in detail. A brief overview of the main results of that assessment are given in this section. Some recommendations on further research to improve the reliability of the data are given in Annex A as well.

Reliable data is available for most countries on total revenue from road transport taxes and charges (see Figure 2A), based on reliable sources or estimates (for more details, see Annex A). The exact allocation per mode of transport is only known in a few countries (i.e. Austria, Belgium, Denmark, Germany, Latvia, The Netherlands) . Additional analysis was therefore needed to estimate the total revenue per mode of transport (methodology applied is described in Section 2.2), which results in a modest level of uncertainty (see Figure 2B).

[6] The following national experts have been deployed for this task: Herry (Austria), Herbert Seelmann (Czech Republic), Nilsson Production (Denmark, Sweden), Setec (France), TRT (Italy), Agnieszka Markowska (Poland), University of Madrid (Spain), CE Delft (Germany, The Netherlands, UK).

Figure 2 **Assessment of reliability of data on tax/charge revenue**

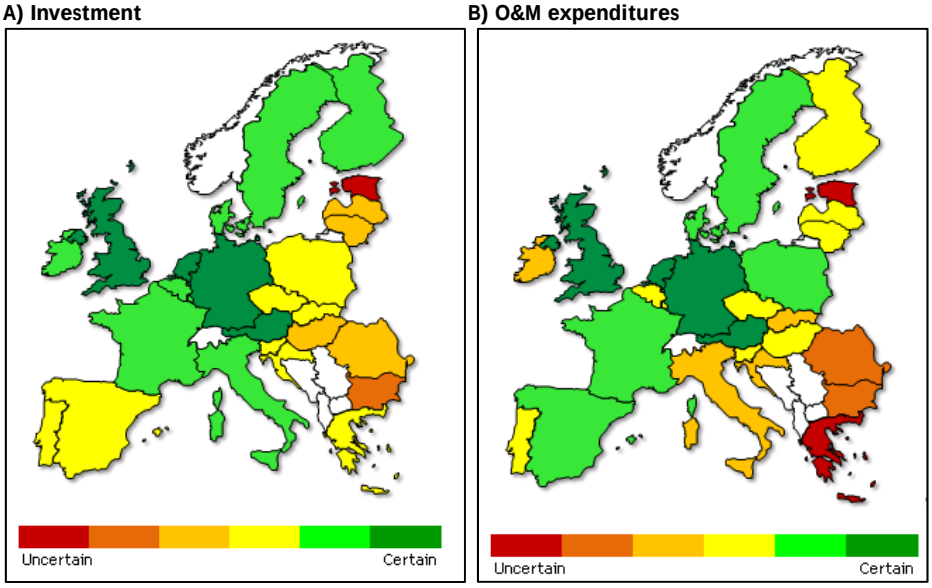
A) Total revenue **B) Allocation of costs to specific modes of transport**



The data on infrastructure expenditures on investments and Operation and Maintenance (O&M expenditures) is less reliable as is shown in Figure 3 (see Section 3.2 for definitions of investments and O&M expenditures). There may be serious concerns regarding the reliability of the expenditure data used for some Central, Eastern and Southern countries. Due to a lack of data for some countries such as Bulgaria, Estonia and Greece, data for those countries has been estimated, which results in significant levels of uncertainty (see Annex A for more details). Furthermore, there are differences in data quality (e.g. level of detail), which affects data reliability. Finally, there may be differences in accounting principles used in the various countries (due to a lack of common definitions and practices to measure infrastructure expenditures), which may hamper the data comparability.

Figure 3 **Assessment of reliability of infrastructure expenditure data**

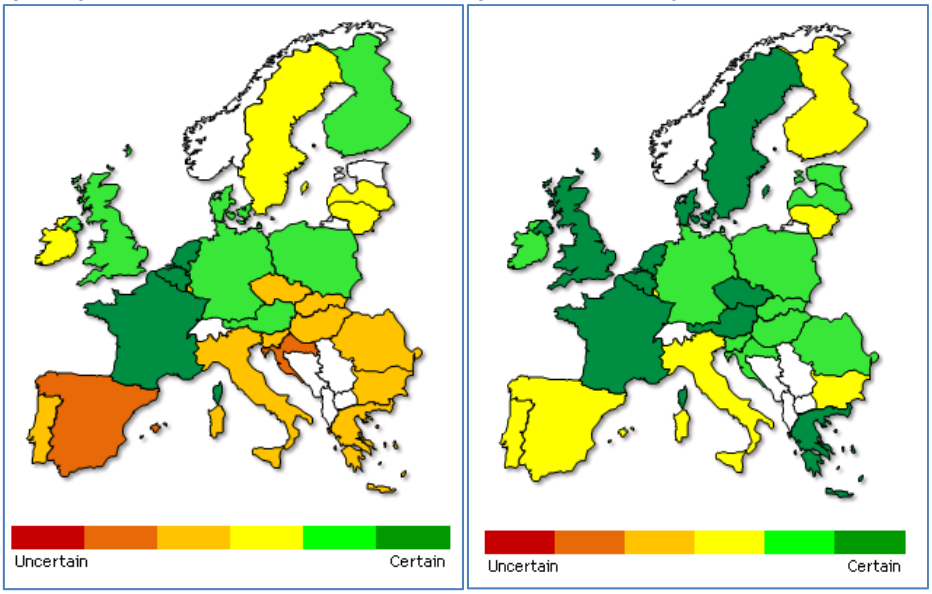
A) Investment **B) O&M expenditures**



As many of the results are presented in terms of €/vkm, €/pkm, €/tkm or €/km road network, the reliability of these variables is interesting to consider as well. The geographical scope of most vkm/pkm/tkm statistics are related to the country in which the vehicle is registered. However, for this study we are interested in the traffic performances on national territory (by both national and foreign vehicles), as this matches with the scope of infrastructure expenditures and tax/charge revenue. The availability of this type of data is rather poor and we therefore have to combine several data sources to complete a consistent set of vkm/pkm/tkm data. These data sources vary in terms of reliability, as is shown in Figure 4A. These uncertainties are reflected in the average tax/charge revenue and average infrastructure cost estimates, as they are expressed in €/vkm, €/pkm or €/tkm. For road network length, on the other hand, relatively reliable data is available for most of the European countries (see Figure 4B). Therefore, results expressed in terms of €/km road network are more reliable than results expressed in €/vkm, €/pkm or €/tkm.

Figure 4 **Assessment of reliability of transport performance indicators and road network length**

A) vkm/pkm/tkm **B) Road network length**



1.5 Outline of the report

In this report, we present data on the revenue from taxes and charges of road transport in Chapter 2. In Chapter 3, we discuss the expenditures on road infrastructure in the period 1995-2013 in the EU. The estimated infrastructure costs are presented in Chapter 4, and are then compared with the revenue from taxes and charges in Chapter 5. Finally, the main conclusions are presented in Chapter 6.

2 Revenue from taxes and charges

2.1 Introduction

Several types of taxes and charges related to the ownership and use of road vehicles and road infrastructures are levied in the EU. In this chapter, we provide an overview of these taxes and charges and their total revenue in 2013. This will provide an answer to the first research question of this study (see the textbox below).

Research question 1

What is the amount of road tax/charge revenue in 2013 in the EU Member States?

This question consists of three sub questions:

1. *What road taxes/charges are applied in the various EU Member States?*
2. *What is the total revenue from these taxes/charges in 2013 for every EU Member State?*
3. *What share do the various vehicle categories have in the total tax/charge revenue?*

In the remainder of this chapter, we first discuss the methodology used to estimate the total tax revenue (per vehicle category) in Section 2.2.
Next, we give an overview of the different types of taxes and charges that are levied in the various EU Member States (Section 2.3). The total revenue from road taxes and charges is considered in Section 2.4, while the average revenue (in terms of €/vkm, €/pkm and €/tkm) is discussed in Section 2.5.

2.2 Methodology to estimate the total tax/charge revenue

Scope

This study covers the following taxes and charges:

- registration taxes/purchase taxes[7];
- ownership taxes (circulation taxes);
- road tolls and vignettes;
- fuel excise duty;
- VAT on registration taxes;
- VAT on vehicle purchases;
- VAT on fuel excise duties;
- VAT on fuel purchases.

Company car taxation and insurance taxation are not covered in this study, as they are not specific transport taxes (e.g. company car taxation is a type of income taxation as it taxes the benefit in kind that is attributed to company cars). It is also questionable to what extent VAT on vehicle and fuel purchased can be considered transport taxes. Eurostat (2001) excludes VAT from the concept of environmental/transport taxes, because it was considered to have

[7] Registration fees are not considered in this study, as these are direct payments for actual activities carried out (i.e. registering vehicles). As the costs of these activities are not considered in these studies, the payments for them should not be included in the analysis as well.

no influence on relative prices (in the transport market) in the same way that other transport taxes do. However, as stated by Steinbach et al. (2009), there is one exception where VAT should be included. In cases where VAT is charged on a tax/duty that is considered a transport tax, VAT should be included in the concept of transport taxes as well. This implies that the VAT charged on fuel excise duties and on registration taxes is considered transport taxes, while VAT on the production costs of fuel and vehicles is not. For this reason, we consider these different types of VAT separately in this chapter.

Finally, the revenue from parking charges is not considered in this study, as the data availability on this issue is very fragmented and poor. We have consulted national statistical agencies as well as the European Parking Association (EPA), but only information on parking revenue in the Netherlands and the UK were found. These results are presented in Section 2.4, in order to provide insight in the potential contribution this revenue has in total road transport tax and charge revenue.

Methodology

A top-down approach was used to estimate the revenue from registration tax, circulation tax and road toll per vehicle type. Total revenue figures were collected from statistical databases or public accounts (see Annex A for the data sources used) and subsequently allocated to the various vehicle types based on relevant allocation parameters (see Table 1). A similar approach was used for the VAT revenue from registration taxes and fuel excise duties. On the other hand, a bottom-up approach was applied to fuel excise duty and VAT revenue. The total revenue per vehicle type was estimated through a multiplication of the total amount of fuel consumed (by new registers vehicles) by the average tax rate. This was carried out separately for each vehicle type.

Table 1 Estimation approach total tax/ charge revenue

Taxes/charges	Estimation approach
Registration taxes	Top-down approach: the total revenue was allocated to the various vehicles by use of 2013 sales volumes (from ACEA, EEA or Eurostat) weighted by the average tax rates per vehicle category.
Ownership taxes	Top-down approach: the total revenue was allocated to the various vehicles by use of the size of the various fleets in 2013 (based on Eurostat data) weighted by the average tax rates per vehicle category.
Tolls and vignettes	Both for road tolls and vignettes, a top-down approach was applied. For road tolls, the total revenue (mainly from ASECAP) was allocated based on vehicle kilometres on tolled roads, weighted by average toll rates per vehicle category. For vignettes, the total revenue is allocated based on the size on the various fleets in 2013, weighted by the average rates.
Fuel excise duty	Bottom-up approach: based on total fuel volumes sold in the various EU Member States and excise duty rates, the total revenue is estimated. The allocation to the various vehicle types was based on the shares the various vehicle categories have in total petrol/diesel/LPG consumption. Fuel excise refund schemes for HGVs in some EU Member States (e.g. France) are taken into account.

Taxes/charges	Estimation approach
VAT on registration taxes	Top-down approach: based on the total revenue from registration taxes per vehicle type and VAT rates in the various Member States, the revenue from VAT on registration taxes per vehicle type was estimated.
VAT on vehicles	Bottom-up approach: based on average sales prices before taxes (from ICCT, ACEA)) and VAT rates in the various Member States, the VAT on new vehicles was estimated. This was only done for passenger cars and motorcycles. For busses, vans and HGVs it was assumed that VAT on vehicle purchases can be recovered. VAT on second hand cars was not considered due to a lack of data.
VAT on fuel excise duties	Top-down approach: based on the total revenue from fuel excise duties per vehicle type and VAT rates in the various Member States, the revenue from VAT on fuel excise duties per vehicle type was estimated.
VAT on fuel	Bottom-up approach: first the VAT per litre was estimated, based on average commodity prices and VAT rates for the various Member States. Next, total revenue was estimated by use of data on total fuel sales in the various Member States (from Eurostat). For busses, vans and HGVs it was assumed that VAT on fuel purchases can be recovered.

2.3 Taxation and charging of road transport in Europe

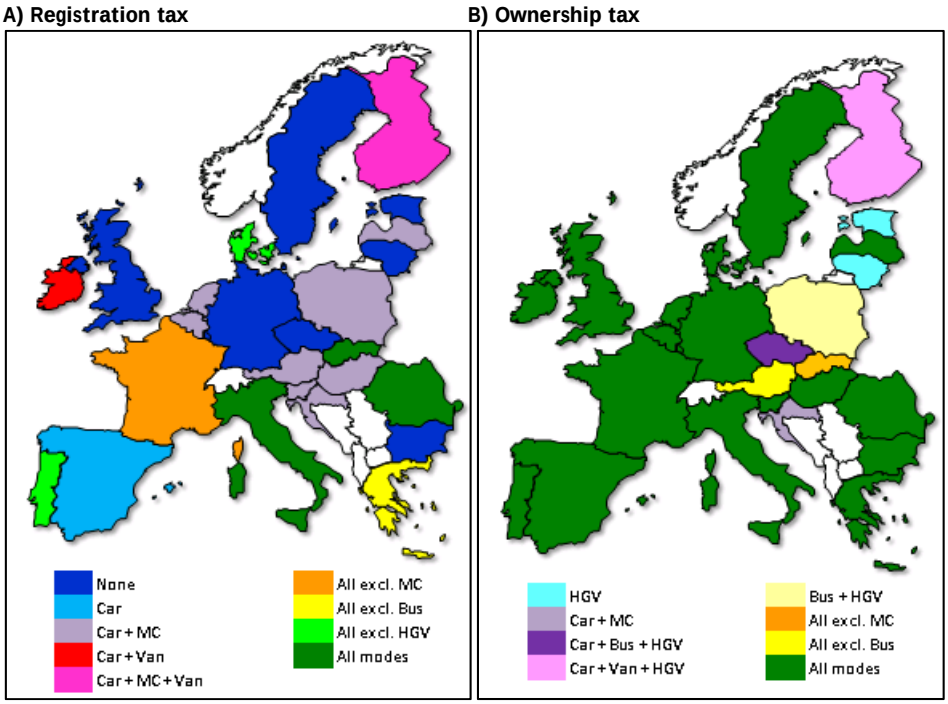
There are large differences in the way road transport is taxed/charged in EU countries. In this section, we present a brief overview of the situation in 2013.[8] The ACEA Tax Guide gives a more detailed overview per country (ACEA, 2013).

2.3.1 Vehicle taxes

Taxation of the registration and/or ownership of road vehicles is applied in all EU Member States, but the scope of these taxes differ widely between countries (see Figure 5). Registration tax (or charge or excise duty) is applied on vehicles (re)entering the fleet in twenty countries, but only three countries (Italy, Romania and Slovakia) apply it to all vehicle types. While owners of passenger cars have to pay registration tax in twenty countries, owners of HGVs only have to pay it in five countries (Italy, Romania, Slovakia, France and Greece).

[8] Notice that in the years after 2013 there have been changes in the taxes and charges that are applied for road transport in some of the EU countries, As 2013 is the base year for our analysis, these changes have not been taken into account in this study.

Figure 5 Vehicle types on which vehicle taxes are levied in 2013



All Member States levy a periodic ownership or circulation tax on road transport vehicles (see Figure 5B). The majority of the countries apply this tax to all vehicle types. Contrary to the registration taxes, HGVs are subject to this form of taxation in nearly all countries; they are only exempted in Croatia. For passenger cars an ownership tax is applied in most countries as well; only three countries (Estonia, Lithuania and Poland) exempt passenger cars from ownership tax (ACEA, 2013).

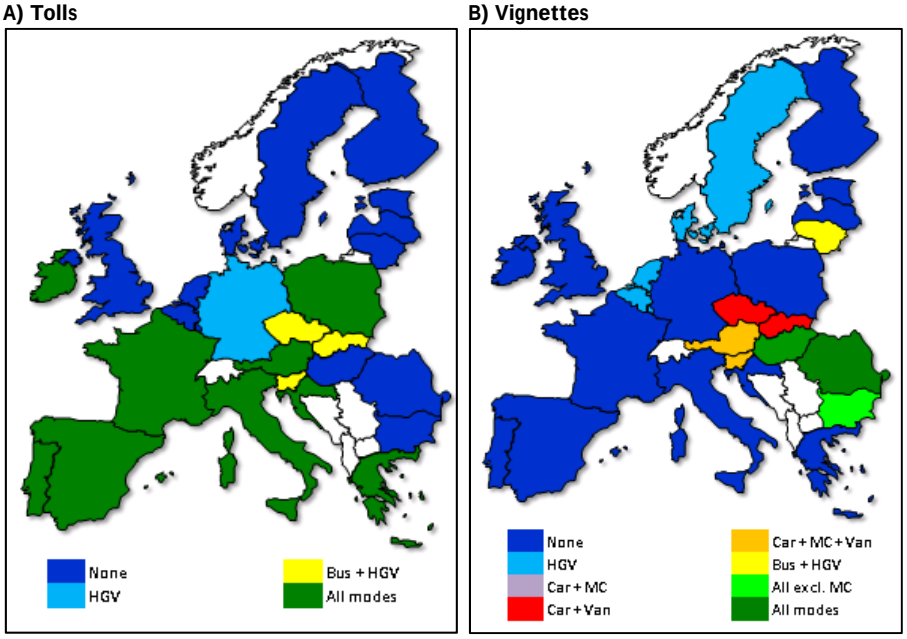
Member States also apply significantly different tax base/structures to registration and circulation taxes (ACEA, 2013). Vehicle value, CO_2 emissions (expressed in g/km) and engine size/power are often used as parameters to define the registration tax rate. Ownership taxes are often based on engine size/power and CO_2 emissions for passenger car or on weight very often combined with axle configuration and suspension for HGV.

2.3.2 Tolls and vignettes

Infrastructure charges are applied in most of the EU Member States. Two main types of infrastructure charges can be distinguished: distance-based systems (tolls) and time-based systems (vignettes). As is shown in Figure 6, nine EU countries apply distance based road charging schemes covering all vehicle types, mainly on (part of) the national road network (ACEA, 2013; CE Delft et al., 2012). Additionally, four countries apply a road charging scheme for heavy duty vehicles: Germany only applies it to HGVs, while the Czech Republic, Slovakia and Slovenia include busses as well. Some countries without nation-wide road tolling apply local schemes for the use of specific infrastructure. Examples include the Oresund Bridge between Denmark and Sweden, the M6 in the UK and various tunnels in Belgium and the Netherlands. Where possible, revenue from these local schemes was included as well (see Annex A for more details).

Figure 6 **Vehicle types for which tolls and vignettes are applied in 2013**

A) Tolls **B) Vignettes**

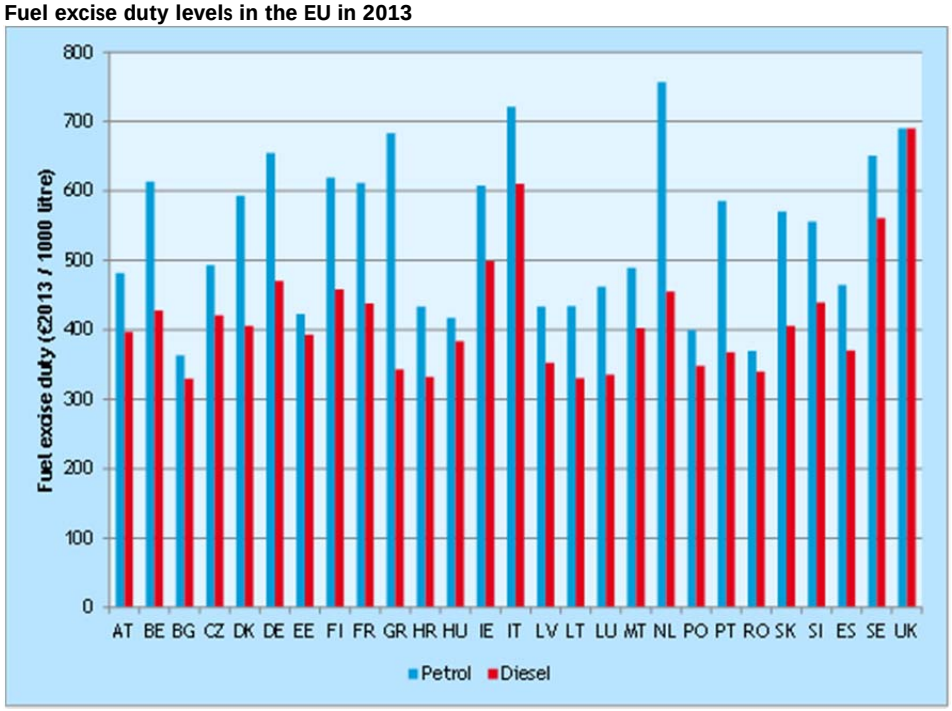


Time-based vignettes are applied in thirteen countries for at least one type of road vehicle. Belgium, Denmark, Luxembourg, the Netherlands and Sweden have a common vignette scheme for HGVs. Vignette schemes are applied in seven Central and Eastern European countries and Austria as well, always covering passenger cars and other vehicle types on a country-by-country basis.

2.3.3 Fuel excise duties

All EU Member States levy excise duties on transport fuels. An overview of the tax levels for the main transport fuels (petrol and diesel) is given in Figure 7. The highest fuel taxes are levied in the Netherlands (for gasoline), Italy and the UK (both gasoline and diesel). The excise duty on gasoline is higher than on diesel in all countries, with the exception of the UK where equal taxes on gasoline and diesel are applied. In some EU countries (i.e. Belgium, France, Hungary, Ireland, Italy, Slovenia and Spain), a refund scheme for part of the fuel excise duty exists for HGVs. These schemes are taken into account in estimating the total tax and charge revenue in the next section.

Figure 7 Fuel excise duty levels in the EU in 2013



Source: European Commission (2013).

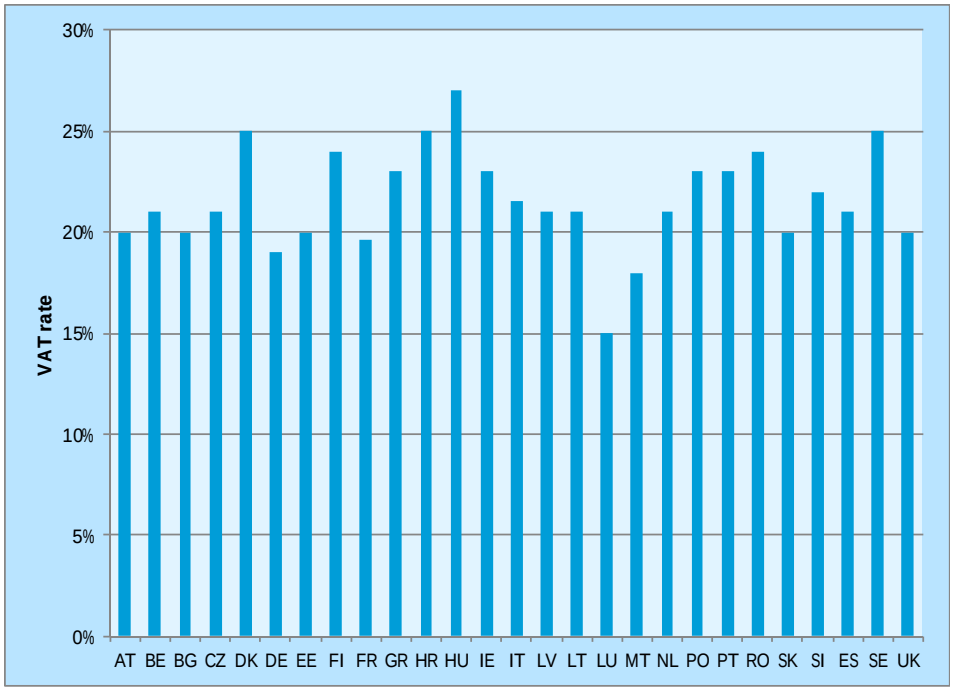
2.3.4 VAT

Value added taxes[9] (VAT) are levied on the purchase of transport vehicles (including registration taxes) and transport fuels (including fuel excise duties) in all EU countries. The VAT rates applied in 2013 are presented in Figure 8. The highest VAT rates are found for Hungary, followed by Denmark, Croatia and Sweden. The lowest VAT rate is applied in Luxembourg.

VAT has to be paid by the final consumer, implying that companies can reclaim their VAT payments on intermediate products. As transport is an intermediate product for companies, they can reclaim all VAT payments on vehicle purchases and transport fuels. For that reason, this study assumes that there are no VAT revenue from busses, vans and HGVs (as these vehicles are mainly used by companies).

9 Indirect taxes on the consumption of goods or services. VAT is imposed on the added value at each stage of production. Producers are VAT-registered and they are entitled to deduct from the VAT amount the VAT paid on his or her purchases. For the final consumer, not being VAT-registered, VAT is a tax on the consumption of a good or service.

Figure 8 VAT rates applied for vehicle purchases and transport fuels in the EU in 2013



Source: ACEA (2013).

2.4 Total revenue from road transport taxes and charges

An overview of the total tax/charge revenue in 2013 in the EU27 is given in Table 2, while the tax/charge revenue in Cyprus are presented in the following textbox. The data sources used and details on the figures' reliability are presented in Annex A. All figures are PPP adjusted to allow comparison between countries (see also Section 1.3). The unadjusted figures can be found in Annex C.

Table 2 Total revenue from road taxes/charges in the EU in 2013 (billion €$_{2013}$, PPP adjusted)

Member State	Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on registration taxes	VAT on fuel excise duty	VAT on vehicle purchase	VAT on fuel	Total (incl. VAT on taxes)	Total (incl. all VAT)
Austria	0.4	1.6	1.5	3.4	0.1	0.6	1.3	0.8	**7.6**	**9.7**
Belgium	0.4	1.5	0.1	3.8	0.1	0.6	1.1	0.8	**6.5**	**8.4**
Bulgaria	-	0.2	0.2	1.9	-	0.1	0.2	0.7	**2.4**	**3.3**
Czech Republic	-	0.3	0.7	4.3	-	0.4	0.9	1.0	**5.6**	**7.5**
Denmark	1.9	1.4	0.4	1.6	0.6	0.4	0.4	0.3	**6.2**	**6.8**
Germany	-	8.1	4.2	32.4	-	5.1	12.5	5.9	**49.7**	**68.0**
Estonia	-	0.01	-	0.5	-	0.0	0.1	0.1	**0.5**	**0.8**
Finland	0.8	0.7	-	2.0	0.2	0.4	0.2	0.2	**4.1**	**4.5**
France	1.8	0.2	9.8	20.1	0.3	3.0	6.2	3.5	**35.3**	**45.0**
Greece	0.1	1.4	0.6	4.0	0.02	0.5	0.2	0.8	**6.7**	**7.7**
Croatia	0.03	0.05	0.5	1.2	0.01	0.1	0.2	0.5	**1.9**	**2.7**
Hungary	0.1	0.2	0.3	2.7	0.01	0.3	0.5	1.0	**3.7**	**5.2**
Ireland	0.4	1.0	0.2	2.1	0.1	0.3	0.2	0.3	**4.1**	**4.7**

Member State	Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on registration taxes	VAT on fuel excise duty	VAT on vehicle purchase	VAT on fuel	Total (incl. VAT on taxes)	Total (incl. all VAT)
Italy	1.3	5.7	6.6	23.3	0.3	4.0	5.5	4.5	**41.2**	**51.2**
Latvia	0.01	0.1	-	0.5	0.00	0.04	0.1	0.1	**0.7**	**0.9**
Lithuania	-	0.1	0.05	1.0	-	0.1	0.1	0.3	**1.2**	**1.6**
Luxembourg	-	0.1	0.01	0.8	-	0.1	0.2	0.1	**0.9**	**1.2**
Malta	0.04	0.1	-	0.1	0.01	0.0	0.01	0.03	**0.2**	**0.2**
Netherlands	1.06	4.6	0.1	6.9	-	0.8	0.4	0.6	**13.5**	**14.8**
Poland	0.59	0.4	0.9	11.2	0.1	0.9	2.2	3.6	**14.0**	**19.9**
Portugal	0.46	0.6	1.0	3.3	0.1	0.4	0.7	1.0	**6.0**	**7.6**
Romania	0.33	0.4	0.5	4.0	0.04	0.2	0.5	1.0	**5.5**	**6.9**
Slovakia	0.01	0.2	0.3	1.6	0.00	0.1	0.4	0.3	**2.3**	**2.9**
Slovenia	0.04	0.2	0.4	1.2	0.01	0.1	0.2	0.3	**2.0**	**2.5**
Spain	0.38	3.1	1.7	13.0	0.1	2.0	2.6	4.5	**20.3**	**27.4**
Sweden	-	1.0	0.2	3.9	-	0.9	1.2	0.5	**6.0**	**7.7**
UK	-	4.7[a]	0.3	28.8	-	4.3	4.5	3.4	**38.1**	**46.0**
EU27	10.2	37.8	30.6	179.7	1.9	25.9	42.6	36.0	**286.2**	**365.0**

[a] No data for Northern Ireland is available. Therefore, data for Great Britain is used as a proxy for the UK.

Revenue from taxes and charges in Cyprus

The total 2013 revenue from road transport taxes and charges in Cyprus amounts to € 0.7 billion (PPP adjusted). About 56% of the revenue is coming from fuel excise duties, while total VAT revenue and vehicle taxes contribute 24% and 20% to total revenue respectively.

No infrastructure charges (tolls and/or vignettes) are applied in Cyprus.

Table 3 Total revenue from road taxes/charges in Cyprus (billion €$_{2013}$, PPP adjusted)

Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on registration tax	VAT on fuel excise duty	VAT on vehicle purchase	VAT on fuel	Total (excl. VAT on vehicle purchase and fuel)	Total (incl. VAT)
0.03	0.1	0	0.4	0.01	0.04	0.03	0.1	0.6	0.7

Table 4 shows that of the passenger modes of transportation, passenger cars have the highest average revenue, followed by motorcycles and busses (€ 41, € 32 and € 8 per 1,000 passenger kilometres, respectively). The average revenue from HGVs is € 86 per 1,000 tonne kilometres. Finally, vans have average revenue of € 48 per 1,000 vehicle kilometres.

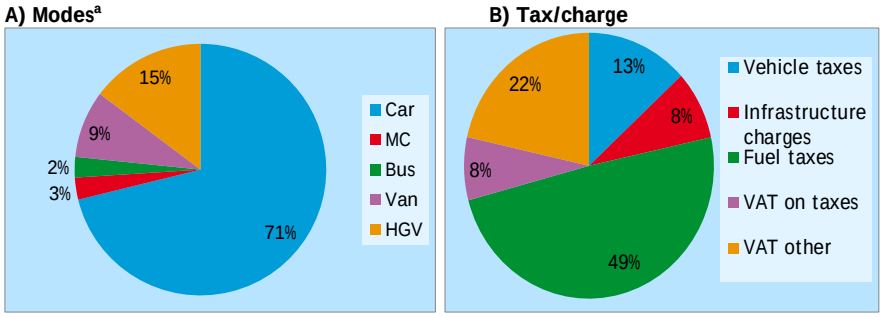
Table 4 Average tax revenue in Cyprus in 2013 (PPP adjusted)

Vehicle type	Average infrastructure costs
Passenger transport (€/1,000 pkm)	
Passenger car	41
Motorcycle	32
Bus	8
Freight transport (€/1,000 tkm)	
HGV	86
Vans (€/1,000 vkm)	
Vans	48

For more information on the data used to estimate these results for Cyprus, see Annex A.

The total revenue from road transport taxes and charges in Europe in 2013[10] is € 365 billion (PPP adjusted), of which € 79 billion are revenue from VAT on vehicle purchases and fuel. The main share of the transport related tax revenue (excl. VAT on vehicle purchases and fuel) is from passenger cars (about 71%), as is shown in Figure 9A. HGVs contribute about 15%, while vans, busses and motorcycles contribute 9%, 2% and 3% respectively. The large share of passenger cars in total tax revenue can be explained by the large share these vehicles have in total fleets and vehicle kilometres.

Figure 9 **Total revenue breakdown per mode of transport and per tax/charge**

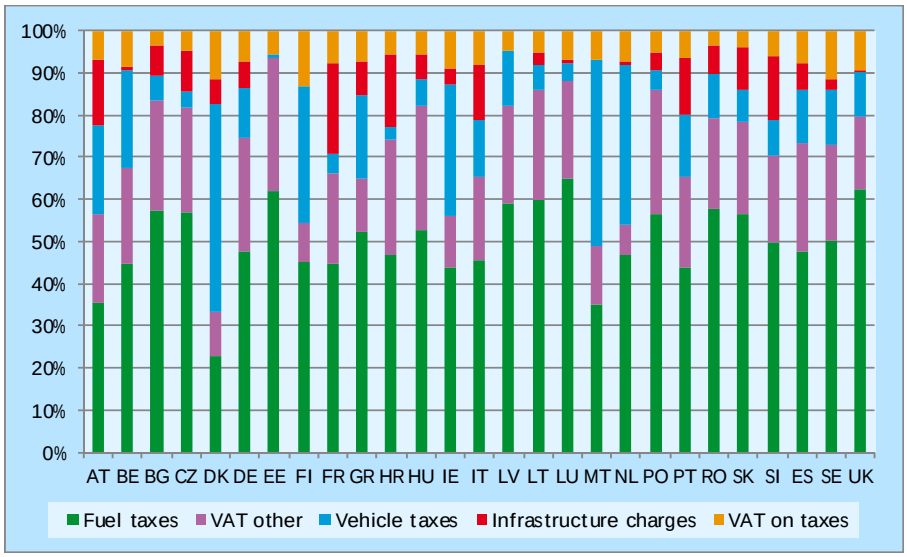


[a] Only transport related tax/charge revenue are considered, which means that revenue from VAT on vehicle purchases (excl. taxes) and fuel (excl. taxes) are not included.

The total revenue of transport taxes and charges consists mainly of fuel excise duties (49%) and VAT payments (30%). Fuel Excise Duty preponderance is linked to the fact that it is levied in every country for all vehicle categories. VAT on car purchases and fuel (both including taxes) is also charged in every country (but not on all vehicles), resulting in a relatively large share in total revenue. The scope of vehicle taxes and infrastructure charges is more limited (see Section 2.3) and their share in total revenue is therefore smaller (13% and 9%, respectively). Figure 10 shows that the contribution of the various taxes/charges to total revenue varies significantly between countries. In Estonia, for example, more than 99% of tax revenue comes from fuel taxes and VAT, while in Denmark they represent less than 45% of total revenue. In the latter country the revenue from vehicle taxes (i.e. registration and ownership tax) are high, as is the case for countries like The Netherlands, Malta and Ireland. In France, Croatia, Portugal, Slovenia and Austria infrastructure taxes contribute significantly to total road tax/charge revenue (10-20%).

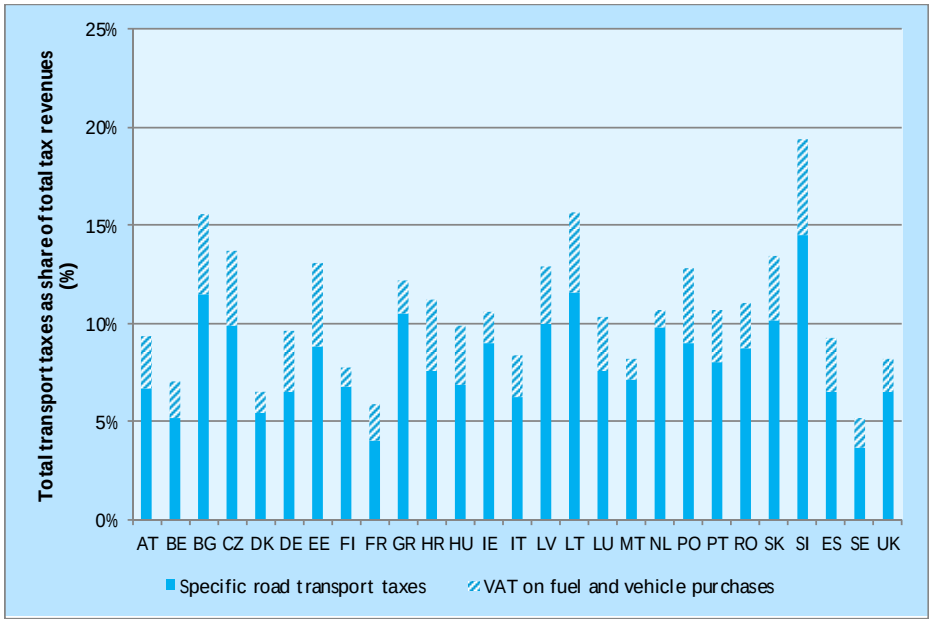
[10] As mentioned in Section 2.2, the revenue of (local) parking charges is not gathered for all EU countries. To give an impression of the share that this revenue can have in total revenue from taxes and charges, we have gathered data on parking charge revenue (from public parking places, both on- and off-street) in the Netherlands and the UK (from the national statistical agencies). In the Netherlands, this revenue was equal to € 566 million (PPP adjusted) in 2013, which is about 4% of the total road transport tax/charge revenue. The 2013 parking revenue in the UK is € 1,183 million (PPP adjusted), which is about 2.5% of the total revenue.

Figure 10 Share of different types of taxes in total road tax/charge revenue in the various EU Member States in 2013



In the majority of European countries, revenue from specific road transport taxes (i.e. registration and ownership taxes and fuel excise duties, VAT on registration taxes and fuel excise duties) contributes 5% to 10% of total tax revenue. In some countries (Bulgaria, Greece, Lithuania, Slovakia and Slovenia) this share is slightly higher (11% to 14.5%), while in France and Sweden the share is slightly lower (about 4%). If revenue from VAT on vehicle purchases and fuel is included as well, the contribution to total tax revenue range from 5% in Sweden to 20% in Slovenia.

Figure 11 Total road transport tax revenue as share of total tax revenue in 2013

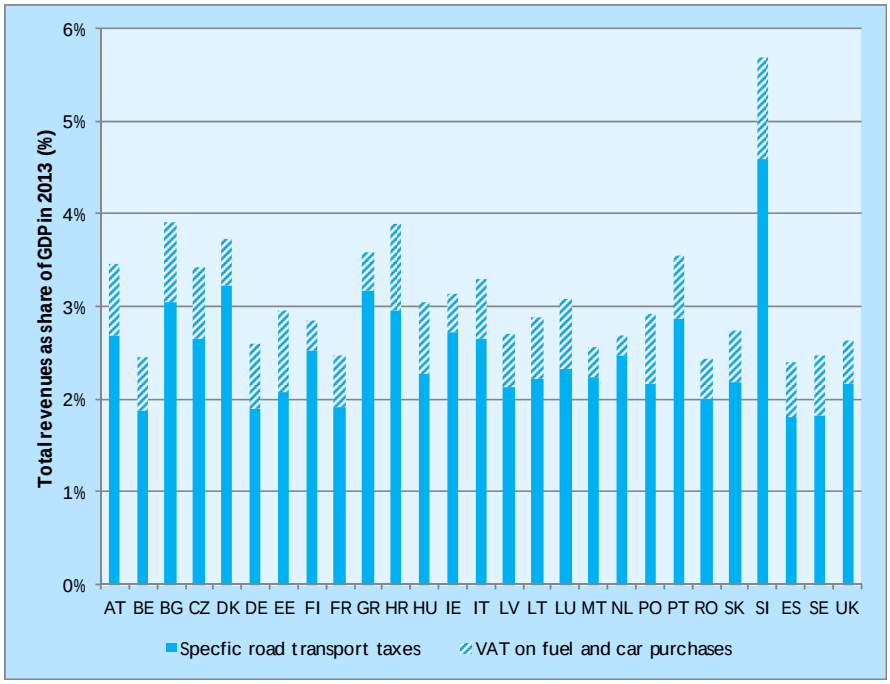


Note:

- The total tax revenue is based on Eurostat data and includes revenue from national, regional and local taxes. Due to differences in scope, the total tax revenue presented by Eurostat may differ from the total revenue presented in national accounts.
- As infrastructure charges are not part of the total tax revenue (charge revenue is not considered tax revenue in public accounting), they are not included in the total road transport tax revenue as well.

Finally, the total revenue from specific road transport taxes/charges (including VAT on registration taxes and fuel excise duties) as share of GDP in 2013 is shown for the various EU countries in Figure 12. In most countries, the revenue collected from these taxes and charges is 2% to 3% of GDP. A main exception is Slovenia, where the revenue from road transport taxes and charges is more than 4% of GDP. Revenue from VAT on vehicle purchases and fuel is equal to 0.2% to 1.1% of GDP in the various EU countries.

Figure 12 Total revenue from road transport taxes and charges as % of GDP in 2013



2.5 Average revenue from road transport taxes and charges

In this section we present the average tax/charge revenue for the various vehicle categories, expressed in €/1,000 passenger kilometres for the passenger transport modes, €/1,000 tonne kilometres for HGVs and €/1,000 vehicle kilometres for vans[11]. Three (complementary) explanations may account for the divergences between countries:

- differences in the actual tax/charge levels applied in the various countries
- differences in average mileage, fuel efficiency, occupancy rate (passenger modes of transportation) and average load (HGVs) between countries; e.g. if vans in one country are on average more fuel efficient than in another country, then the fuel tax revenue per vehicle kilometre will be lower in the former country.
- differences in price level (purchasing power) between countries; as we correct the revenue for differences in purchasing power in the various EU countries, the revenue in countries with a relatively low average price level (e.g. Romania) is corrected upwards, and vice versa (see Section 1.3 for a more detailed explanation).

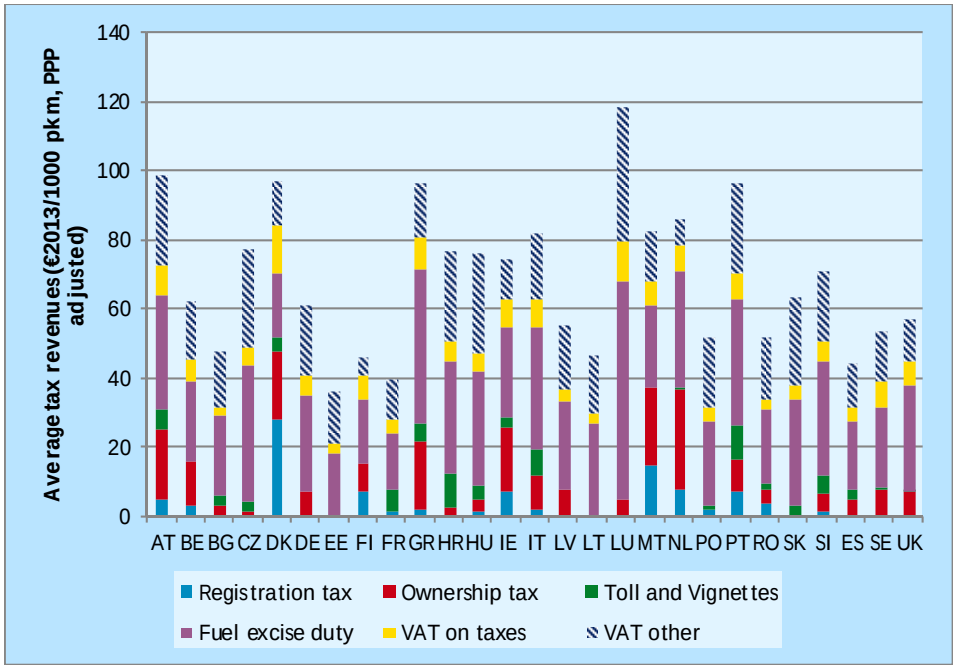
[11] Graphs showing the average revenue in €/1,000 vehicle kilometres for passenger cars, motorcycles, busses and HGVs are presented in Annex D.

2.5.1 Passenger transport

Figure 13 presents the average tax/charge revenue for passenger cars in 2013. This revenue is highest in Luxembourg, which is mainly due to the relatively high fuel excise duty revenue and VAT on fuel per passenger kilometre. This is the result of the large level of foreign vehicles fuelling up in Luxembourg to take advantage of the relatively low fuel prices (see Figure 7). As these vehicles mainly use the fuel purchased in Luxembourg for passenger kilometres made in other countries, the fuel excise duty revenue per passenger kilometres in Luxembourg is relatively high. Tank tourism may have an impact on the fuel excise duty revenue of other countries as well (e.g. Austria, Germany and Ireland), but to a lesser extent than in Luxembourg.

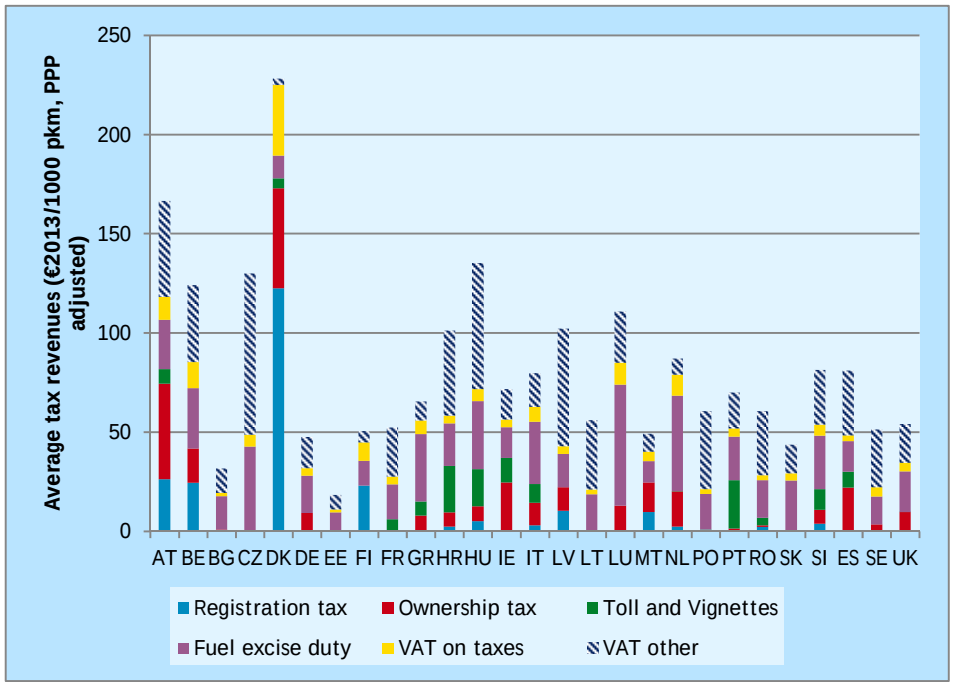
Fuel excise duties are the main source of revenue for most EU countries with the exceptions of Denmark, Malta, The Netherlands and, to a lesser extent, Austria and Ireland. Most of these countries have rather high vehicle tax levels (per vehicle). In Malta, the relatively low annual mileages also contribute to high revenue of vehicle taxes per passenger kilometre.

Figure 13 Average revenue from taxes and charges for passenger cars in 2013



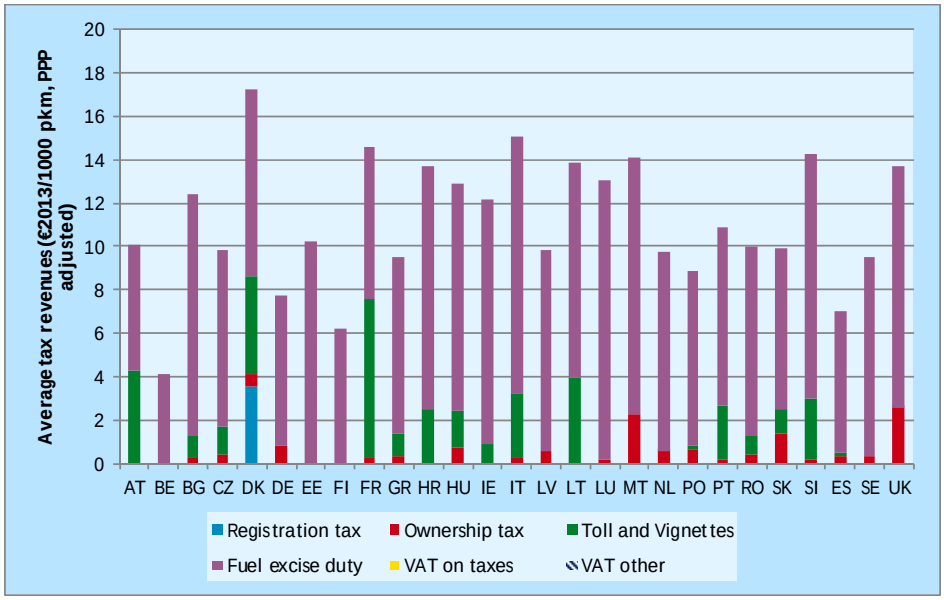
For motorcycles, the highest average revenue of taxes/charges is found for Denmark and Austria. For Denmark, this is mainly due to the high level of registration taxes for motorcycles, while in Austria both registration and ownership taxes on motorcycles are relatively high. Relatively low average tax/charge revenue for motorcycles is found for Bulgaria, Estonia, Slovakia and Sweden. In these countries, no vehicle taxes and infrastructure charges are levied on motorcycles, resulting in relatively low average revenue.

Figure 14 Average revenue from taxes and charges for motorcycles in 2013



The average revenue from taxes and charges for busses (per passenger kilometre) is considerably lower than for passenger cars and motorcycles. In most countries, no or relatively low vehicle taxes are levied on busses, resulting in low total revenue.

Figure 15 Average revenue from taxes and charges for busses in 2013

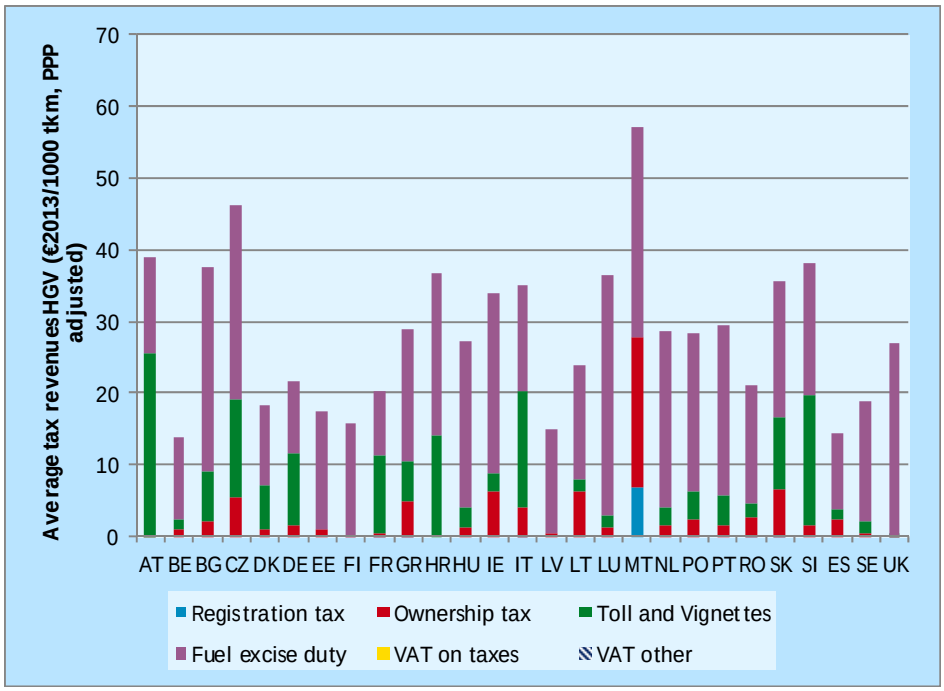


2.5.2 Freight transport

The average tax revenue for HGVs (expressed in €/1,000 tkm) is shown in Figure 16. As for the other modes of transportation, fuel excise duty revenue account for the main part of the tax/charge revenue. However, in countries

with HGV charging schemes (Austria, Czech Republic, Germany, Slovakia, Slovenia) and countries with more general road charging schemes (e.g. France, Italy, Croatia) the contribution of tolls to total revenue is significant as well. In general, the average revenue in these countries is higher than in countries without a large-scale HGV road charging scheme. The very high average revenue found for Malta can be explained by the low number of tonne kilometres (due to low average trip lengths and low average loads), resulting in high vehicle taxes per tonne kilometre.

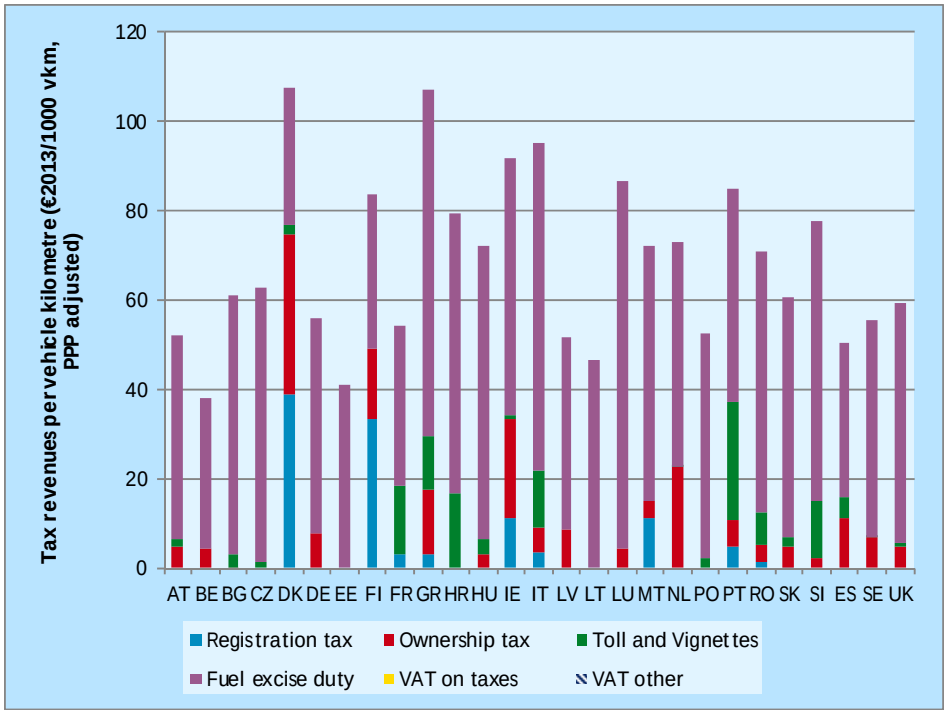
Figure 16 Average revenue from taxes and charges for HGVs in 2013



2.5.3 Vans

As for the passenger transport modes, the average tax and charge revenue from vans is highest in Denmark, which is mainly due to the high vehicle taxes in this country. In Greece the average tax/charge revenue from vans is high as well, which is due to the relatively high fuel excise duty on petrol (and the large share of petrol vans in Greece). Additionally, significant vehicle taxes (mainly ownership taxes) are levied on vans in Greece. The lowest average revenue is found in Belgium, Estonia and Lithuania. In these countries, vans are (almost) exclusively taxed by the fuel excise duty.

Figure 17 Average revenue from taxes and charges for vans in 2013



3 Infrastructure expenditures

3.1 Introduction

National, regional and local governments (and some private road owners[12]) spend significant amounts of money on expanding, renewing and maintaining the road infrastructure network in Europe. However, the size and composition of these expenditures differ widely over time and between Member States. In this chapter, we present and discuss the expenditures on road infrastructure in Europe for the period 1995-2013, taking into account these temporal and geographical differences.

This chapter provides answers on the second research question (and underlying sub questions) (see textbox below). In order to give these answers, we first briefly define road infrastructure expenditures (Section 3.2). Next, we present and discuss the evidence on investments in road infrastructure. The same is done for operational and maintenance (O&M) expenditures in Section 3.4.

Research question 2

What is the amount of the expenditure on road infrastructure in 2013 in the EU Member States?

This question consists of three sub questions:

1. *Which expenditures on road infrastructure should be considered?*
2. *What has been the size of these different categories of road expenditures in 2013 and over time (1995-2013)?*
3. *Are there significant differences between EU Member States with respect to these expenditures and how can these differences be explained?*

3.2 Defining road infrastructure expenditures

In this study, we define infrastructure as the physical and organisational network, which allows movements between different locations (HLG, 1999). These are roads, but also the organisation of the traffic (e.g. traffic management systems). Parking places are considered to be part of the road infrastructure as well. However, since the data availability on expenditures on (public) parking places in Europe is rather poor, we could not take them into account[13].

The actual amounts of money extracted annually from public (or private) accounts to finance infrastructure are called infrastructure expenditures. VAT payments are not included in these figures. An overview of infrastructure

12 E.g. operators of concessionary roads. As we look at the total expenditures on road infrastructure, spending by private agents should be considered as well.

13 Consultation of the European Parking Association made clear that expenditure data on parking places is not available at the EU level. The 11 country analyses carried out in this study (see Section 1.4) didn't provide any useful input on these expenditures either, except for the Netherlands. Therefore, we only present an estimation of the costs of Dutch parking places in the next chapter.

expenditures therefore provides an understanding of the direct impact of infrastructure on these budgets. As infrastructure expenditures are not directly comparable to tax/charge revenue data, infrastructure costs are estimated in this study as well (Chapter 4).
This is further explained in the textbox below.

Expenditures vs. costs

Accounting for the total resources consumed by the construction, maintenance and operation of long life road infrastructures can either be done by simply summing up expenses or by using (real economic) costs. In contrast to expenditures, costs do take the financing costs or – regarded from a different point of view – the opportunity costs for not spending the resources for more profitable purposes, into account. Financing (or opportunity) costs are expressed by the interest on capital. As financing of road infrastructure is an issue for public bodies (as well as for private investors), full economic cost data are preferred to summing up expenditures in all cases.

Furthermore, infrastructure expenditures may vary widely over time, e.g. due to long planning and construction phases of big projects, which means that they cannot accurately reflect the actual costs caused by road transport to the infrastructure. For example, the investments in a road built in 2000 are zero in 2013, but as this road is used by vehicles in 2013 as well, part of these investments should be allocated to the vehicles in 2013. This can be done by applying a cost accounting approach (see Chapter 4).

In this study, we distinguish between investments and operational and maintenance (O&M) expenditures (ITF, 2013b):

- Investments: expenditures on the enhancement and renewal of the road infrastructure network. Renewal refers to major renovations increasing the performance of existing infrastructure assets or extending their previously expected service lives. These expenditures can be undertaken at any time and are not directly dictated by the condition of the asset.
- O&M expenditures: expenditures associated to 'ordinary' maintenance, i.e. maintenance that cannot be avoided, as the assets that are to continue to be used, are part of the O&M expenditures. These activities do not change the performance of the infrastructure asset, but simply maintain it in good working order or restore it to its previous condition in the event of breakdown. Operation expenditures are made to enable an efficient use of the infrastructure (e.g. lighting).

An (non-exhaustive) overview of the main elements of the various expenditure categories are given in the following textbox[14].

Overview of main elements of road infrastructure expenditures

Enhancement expenditures

- expenditures on preparation of investments in new roads or expansion of existing roads (e.g. feasibility studies);
- expenditures on building new roads (including expenditures on bridges, noise barriers, etc.);
- expenditures on expanding existing roads.

[14] Preferably all these elements are included in the infrastructure expenditure figures presented for the various countries in Sections 3.3 and 3.4. However, as for most countries, only data in aggregated form was available; we were not able to check to what extent all these elements were included.

Renewal expenditures

- Large scale maintenance (economic lifetime > 2 years) of road surfaces, bridges, fly-overs and other infrastructure assets (e.g. noise barriers). These expenditures improve the performance of the asset and extend its economic lifetime.

Maintenance expenditures

- small repairs to the road surface, bridges/fly-overs and other constructions (economic life-time < 2 years), without improving the actual performance of the asset;
- maintenance of street lightning;
- maintenance of traffic signs and traffic lights;
- maintenance of road sides.

Operational expenditures

- traffic police;
- traffic management (systems);
- overhead costs infrastructure managers (housing, vehicles, energy, etc.);
- charging road tolls;
- cleaning icy/snowy roads;
- Lighting.

Assessing maintenance expenditures (both 'ordinary' maintenance and renewal), could be based on actual expenditures or on the so-called 'standard cost approach'. The latter refers to the expenditures related to the minimum package of maintenance (and operational) measures required to ensure the long-term physical and functional integrity of existing infrastructure under current conditions ('steady state level'). This approach corrects infrastructure spending, which is systematically below (or above) what is needed for maintenance. It hence provides a better starting point for the calculation of the infrastructure costs. Our analyses focus on the actual infrastructure expenditures, since no steady state level figures are available for most member states.

3.3 Investments in road infrastructure

3.3.1 Total investments

Table 5 gives an overview of the total investments in road infrastructure in the EU. Both the average annual investments in the period 1995-2013 and the investments in 2013 are presented (see Annex A for the data sources and a discussion on the reliability of the data). All figures are PPP adjusted to allow comparison between countries (see also Section 1.3). The unadjusted figures can be found in Annex E.

Table 5 Total investments in road infrastructure (mln €$_{2013}$, PPP adjusted)

Member State	Long-term (1995-2013) average annual investments	Investments in 2013	Ratio 2013 investments/long term average annual investments
Austria	1,978	1,648	83%
Belgium	1,568	1,461	93%
Bulgaria	509	709	139%
Czech Republic	2,275	1,278	56%
Denmark	829	746	90%
Germany	10,198	9,340	92%

Member State	Long-term (1995-2013) average annual investments	Investments in 2013	Ratio 2013 investments/long term average annual investments
Estonia	174	164	94%
Finland	705	865	123%
France	10,908	9,451	87%
Greece	2,237	1,295	58%
Croatia	1,356	850	63%
Hungary	1,273	737	58%
Ireland	1,287	710	55%
Italy	8,640	3,215	37%
Latvia	218	202	93%
Lithuania	424	391	92%
Luxembourg	164	181	110%
Malta	39	62	159%
The Netherlands	5,068	5,124	101%
Poland	4,414	4,068	92%
Portugal	2,900	384	13%
Romania	5,765	7,534	131%
Slovakia	664	485	73%
Slovenia	656	154	23%
Spain	9,302	3,951	42%
Sweden	1,134	1,441	127%
United Kingdom	6,304	6,400	102%
EU27	80,989	62,846	78%

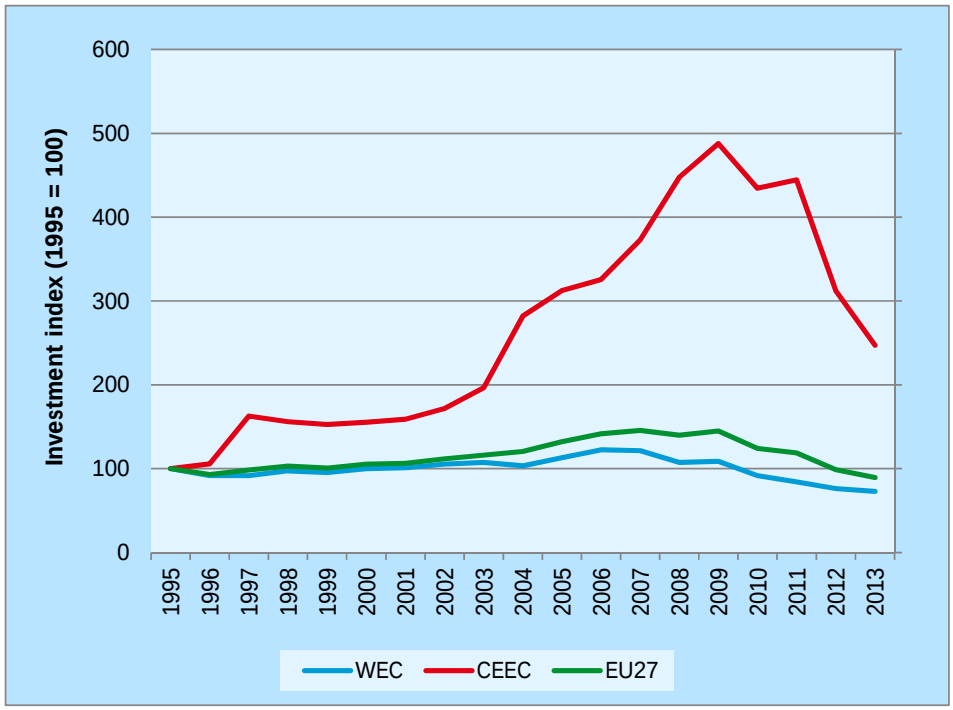
Note: As no reliable data on Cypriot road infrastructure investments was available, Cyprus is not shown in this table.

In most Member States, 2013 investments were below the long-term annual investments. For the EU27 as a whole, the 2013 investments were about 78% of the long-term annual investments. This decrease in total annual investments in road infrastructure is also seen in Figure 18. From 2007/2008 (the start of the economic crisis), road infrastructure investments strongly decreased in Western European countries (WEC)[15], while they decreased later in Central and Eastern European countries (CEEC)[16] (2011-2013). Figure 18 also shows the significant increase in road infrastructure investments between 2003-2011in Central and Eastern European Countries, reflecting efforts to meet rising needs for road network capacity. Additionally, extensive funding from European programmes (mainly Cohesion and Structural funds) came available for these countries, which were used to finance these efforts.

[15] WEC includes: Austria, Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Spain, Sweden and the UK.

[16] CEEC includes: Bulgaria, Czech Republic, Estonia, Croatia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

Figure 18 Investment index for road infrastructure in the period 1995-2013



Note: The indices are based on investments in €$_{2013}$.

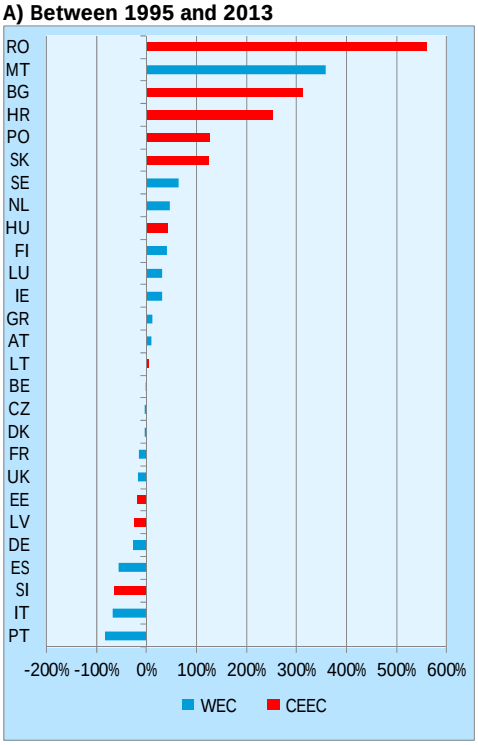
When we zoom in on investment levels in the individual Member States over the period 1995-2013 (see Figure 19A and Annex E for more details), we see that the countries which show the highest growth rates in investments are mainly located in Central and Eastern Europe. Particularly in the period before 2007 (see Figure 19C) the investment levels in these countries rose significantly. Investment also increased significantly in Malta between 1995-2013, more particularly between 2005 and 2013 (see Annex E). In 2004 Malta joined the EU, which gave them access to EU funding for investments in road infrastructure. The largest decline in investment levels are found for Southern European countries like Portugal, Spain and Italy. Large-scale road infrastructure investment programmes were implemented in the nineties in these countries (EEA, 2002) resulting in a high base level of investments. But at the same time Portugal, Spain and Italy are among the European countries most severely affected by the economic crisis, resulting in significant cuts in road infrastructure investment budgets since 2008/2009 (see also Figure 19B).

Portugal, Spain and Italy were not the only countries to cut infrastructure investment in recent years: Figure 19B shows that investment levels in most European countries actually decreased over the period 2008-2013. In many of these countries, the economic crisis is probably (one of) the main explanation(s) for this trend. Bulgaria and Malta are exceptions, which is probably the result of major road investment programmes mainly financed through EU funds (which were not drastically cut during the crisis). In some new EU member countries (e.g. Romania, Lithuania), EU funding has contributed to relatively high investment levels over the period 2008-2013 as well (see Annex E). However, for these countries, the peak in investment levels was already in 2008/2009 and a decreasing trend in investment levels (partly explained by the economic crisis) is therefore found for these countries (Steer Davies Gleave, 2014). Finally, in countries with a mature road network

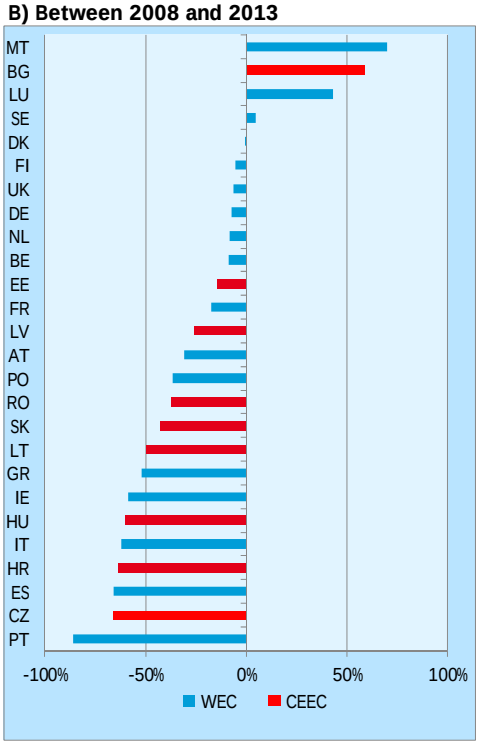
(e.g. Denmark, Germany, France, The Netherlands, UK) investment levels are – as expected – rather stable over time. Over the period 2008-2013 investment levels only slightly decreased, indicating that the economic crisis had only a limited impact on investment budgets in these countries.

Figure 19 Change in investments over time

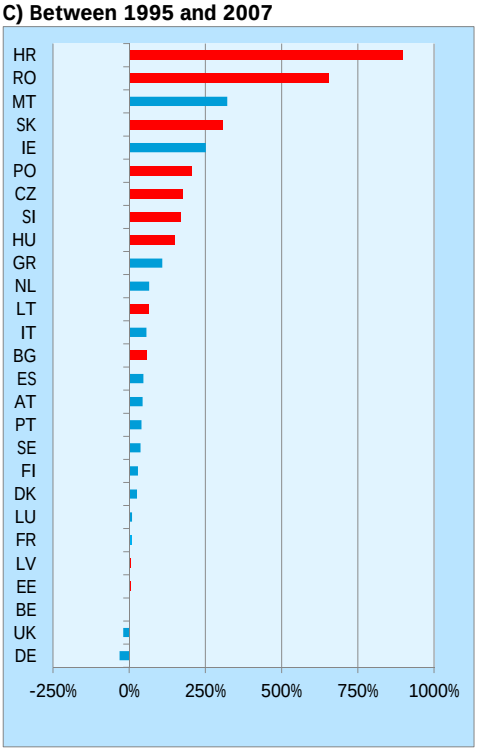
A) Between 1995 and 2013



B) Between 2008 and 2013



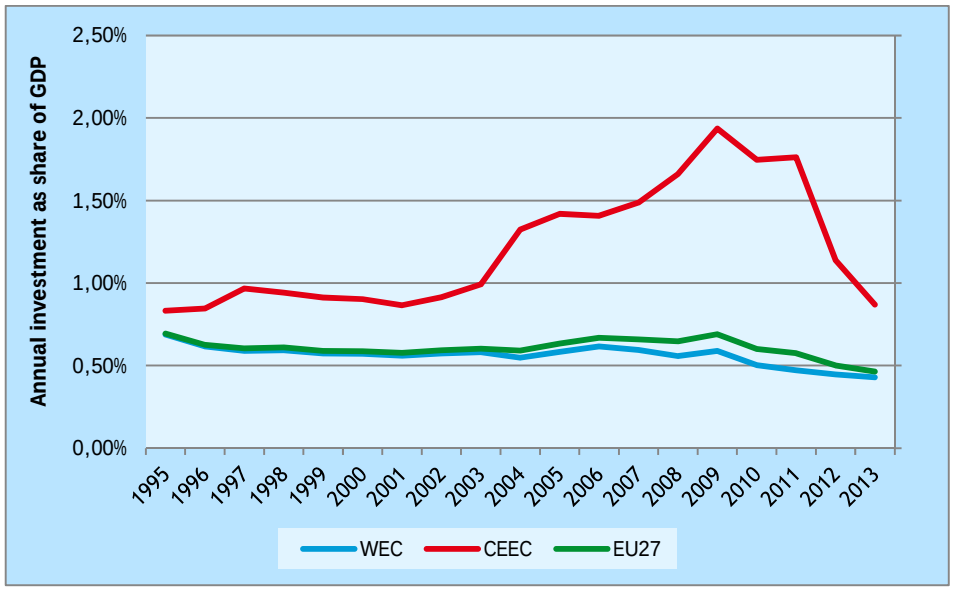
C) Between 1995 and 2007



3.3.2 Investments as share of GDP

Although the investment needs for road infrastructure depend on a number of factors, such as the quality and age of the existing infrastructure and the geography of the country, showing the investments as percentage of Gross Domestic Product (GDP) may provide a useful benchmark for comparing investment levels between countries[17]. Figure 20 shows that till 2009, the investments as share of GDP remains quite stable, followed by a decline due to the economic crisis. Significant different patterns are found for Western European and Central and Eastern European countries. In Western European countries the investments as percentage of GDP slowly decline over the period 1995-2013. In this period, the investment share of GDP fall from 0.7% in 1995 to 0.4% in 2013. This decline is a continuation of the downward trend reported by ITF (2013a) for the period before 1995; the investment share of GDP in Western Europe declined from 1.5% in 1975 to 1.2% in 1980 to slightly below 1% in 1995. Recently (2009-2013), the decline has accelerated, which may be due to the economic crisis. Central and Eastern European countries show a completely different pattern. As the investment share of GDP for this group of countries is rather stable over the period 1995-2003, a sharp increase is identified for the period 2004-2011 (in line with the findings in Section 3.3.1).

Figure 20 Development in share of investments in GDP over time



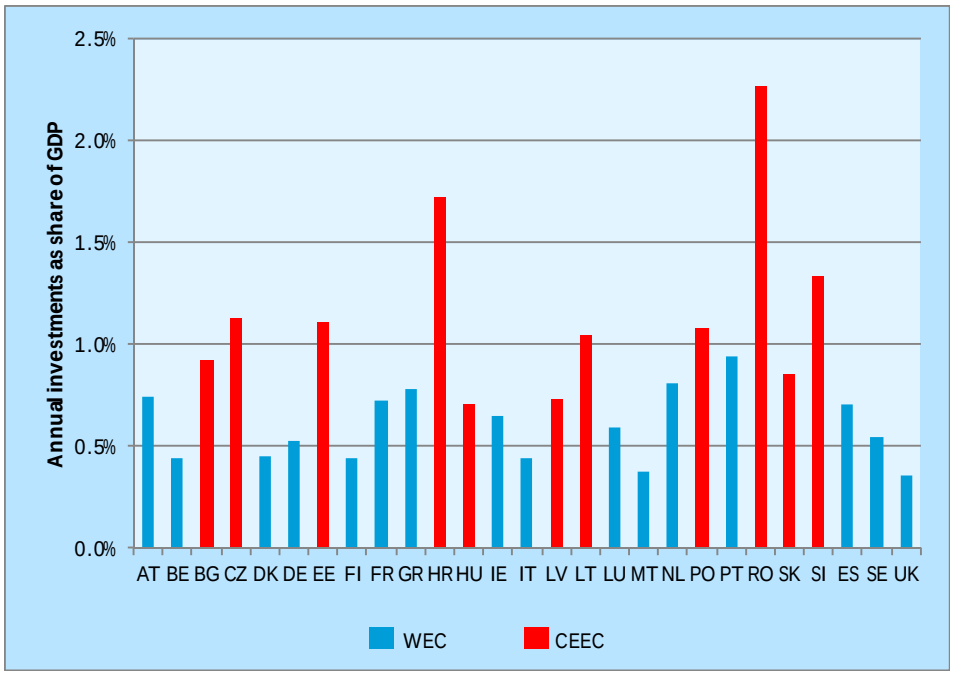
In Figure 21, the long-term share of investments as percentage of GDP, is shown for individual EU countries (for more detailed data, see Annex E). For Western European countries, the share lies between 0.4 and 0.8%. The relative investment levels have only been higher in Portugal (i.e. 0.95%), which can be explained by large investment programmes in the nineties (mainly financed by EU funds) and particularly the first decade of this century (with a significant role for public private partnerships)[18]. As a result, the

[17] Because of the dependency of investment needs for road infrastructure on a large number of factors it is not possible to define an absolute benchmark for road investments (e.g. 1% of GDP).

[18] However, it is also mentioned in the literature that several investment projects are unnecessary and management and corruption in public-private partnerships are a matter of

quality of Portuguese road infrastructure was ranked as fourth worldwide by the World Economic Forum in 2013 (WEF, 2014). The investment levels in Portuguese road infrastructure (and hence the share of these investments in GDP) have declined significantly over the last years, and hence the long-term investment level of Portugal is converging closer to the WEC average.

Figure 21 Investments as share of GDP (average shares for the period 1995-2013)



The share of investments in road infrastructure in GDP lies significantly higher in CEEC countries than in WEC countries: between 0.7 and 1.3%. In two countries, the road infrastructure investment share of GDP is even higher: 2.3% in Romania and 1.7% in Croatia. However, the explanations for these relatively high investment levels (compared to other CEEC countries) differ significantly between both countries.

In Romania, inefficiencies in the planning and construction phase are considered the main reason for the relatively high investment levels[19]. A lack of (government) expertise in construction management (partly caused by a lack of appropriately skilled labour), a lack of competition between construction companies, and a relatively high level of corruption results in relatively high investment levels (IMF, 2015); (Ove Arup & Partners , 2010); (WBG, 2011). The relatively high investments in Croatia, on the other hand, are mainly caused by very ambitious investment programmes in the second half of the nineties and the first decade of this century, aimed to reconstruct

great concern (Pereira & Pereira, 2015), which may also have contributed to relatively high investment levels.

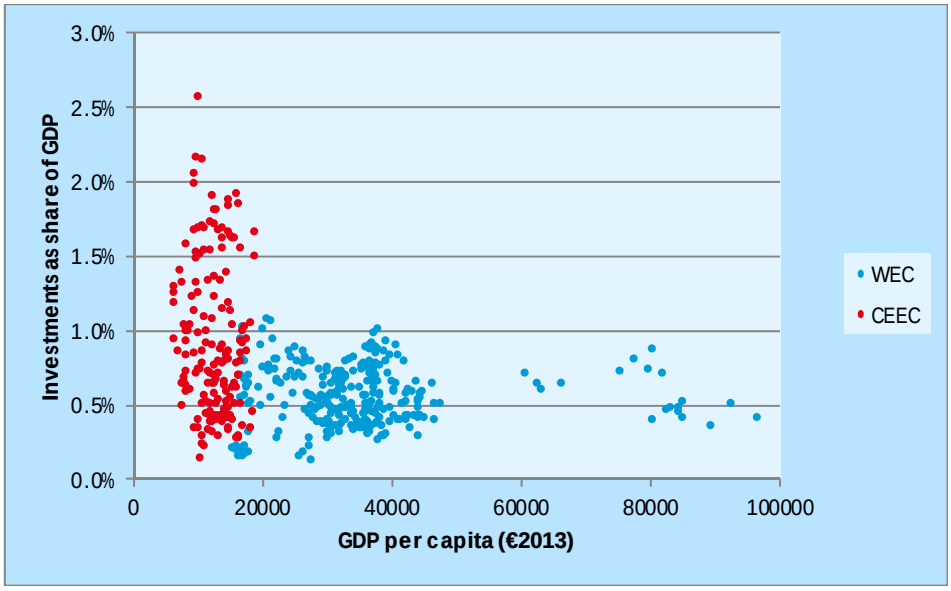
19 These type of inefficiencies are not only found in Romania, but also in other European countries. However, according to the literature, these inefficiencies are larger in Romania than in most other European countries.

war damaged infrastructure, to modernise existing and to build new infrastructure[20] (WBG, 2004); (WBG, 2015).

Relation between income levels and investment levels

The difference between Western European Countries and Central and Eastern European countries suggests a relationship between road infrastructure investments and the level of income. This relationship is influenced by the correlation between Member States income levels and access to EU funding. Figure 22 shows the investments as a percentage of GDP against GDP per capita using panel data for 27 EU countries for the period 1995-2013. Higher levels of investments (> 1% of GDP) are in general only found in countries with an average GDP/capita lower than € 20,000. A possible explanation may be that emerging economies need an increase in road capacity, while production becomes relatively less transport intensive if economies become more developed[21] (McKinnon, 2006), weakening the link between GDP growth and infrastructure investments (ITF, 2013a). In fact, at GDP/capita levels above € 20,000, there seems to be no clear correlation between investment levels and income levels. Assuming that GDP/capita is an important driver of transport demand and hence a good proxy for actual needs for investments in road infrastructure, this may suggest that investment levels are guided by other factors (e.g. historical budget levels or budget allocation procedures) than actual investment needs as well (see ITF, 2013a).

Figure 22 Relationship between income levels and investments in road infrastructure



Note: This graph is based on panel data for the EU27 for the period 1995-2013. Every dot represents the combination of investments as share of GDP and GDP per capita for a specific country (e.g. Belgium) in a specific year (e.g. 2002). In total, there are 513 dots (27 countries x 19 years).

[20] An illustration of the ambition level of these programmes is the large increase in the length of motorways in Croatia over the last twenty years: from 36 km in 1995 to 1,296 kilometre in 2013. This implies that the motorway density has increased to almost 23 km/1,000 km^2, which is just above the average motorway density in WECs (21.9 km/1,000 km^2) and far above the density in CEECs (6.9 km/1,000 km^2).

[21] In other words, the ratio of transport movements to GDP declines.

3.4 Operational and maintenance expenditures

3.4.1 Total O&M expenditures

The total O&M expenditures on road infrastructure in the EU is given in Table 6. Both the average annual O&M expenditures for the period 1995-2013, as well as the expenditures for 2013 are presented (see Annex A for the data sources and a discussion on the reliability of the data). Total O&M expenditures unadjusted for PPP can be found in Annex E.

Table 6 **Total O&M expenditures on road infrastructure (mln €$_{2013}$, PPP adjusted)**

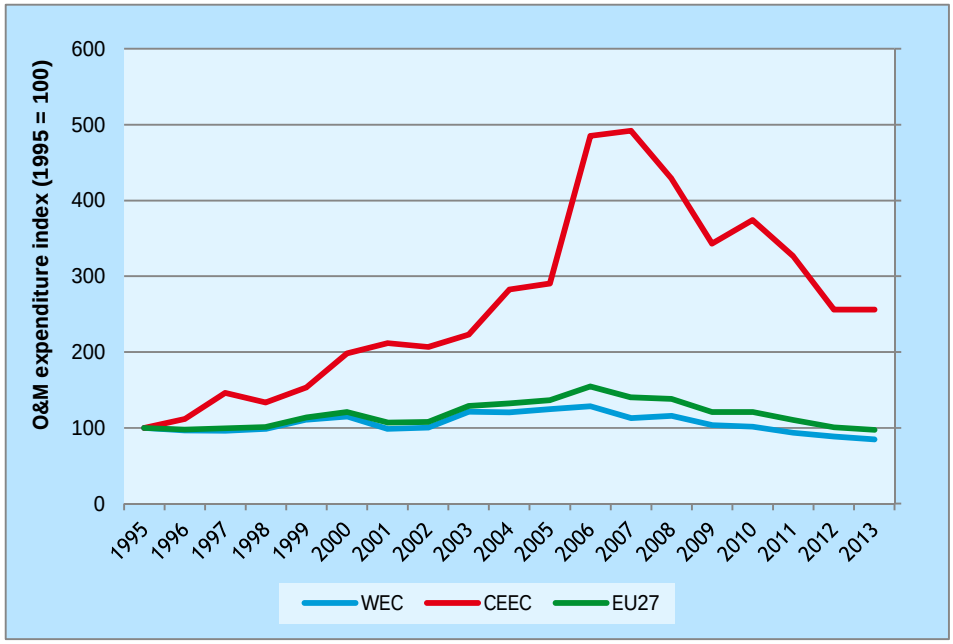
Member State	Long-term (1995-2013) average annual O&M expenditures	O&M expenditures in 2013	Ratio 2013 O&M expenditures/long term average annual O&M expenditures
Austria	2,807	2,113	75%
Belgium	1,029	1,041	101%
Bulgaria	236	285	117%
Czech Republic	1,060	990	93%
Denmark	887	656	74%
Germany	5,436	6,879	127%
Estonia	136	148	109%
Finland	1,187	825	69%
France	6,310	6,559	104%
Greece	452	342	76%
Croatia	589	602	102%
Hungary	1,650	1,471	89%
Ireland	256	297	116%
Italy	11,486	5,432	47%
Latvia	152	193	127%
Lithuania	320	282	88%
Luxembourg	55	62	111%
Malta	11	6	60%
The Netherlands	1,716	1,448	84%
Poland	839	761	91%
Romania	761	576	76%
Portugal	2,677	2,606	97%
Slovakia	303	393	129%
Slovenia	272	260	95%
Spain	3,945	2,967	75%
Sweden	1,050	1,377	131%
United Kingdom	5,075	3,473	68%
EU27	50,699	42,040	83%

Note: As no reliable data on Cypriot road infrastructure investments was available, Cyprus is not shown in this table.

The 2013 O&M expenditures were slightly below long-term annual expenditures in the EU27 (about 7%). This is due to lower O&M expenditure levels in Western European countries. O&M expenditures in these countries are slightly increasing in the period 1995-2006 (with a brief decline in the beginning of this century), but are steadily decreasing in the years following (see Figure 23). In Central and Eastern European countries, O&M expenditures have been rising sharply from 1999 till 2007. In the following years,

expenditures are declining again (e.g. due to the economic crisis), although O&M expenditures in these countries are still significantly higher in 2013 than in 1995. In Annex D, more detailed figures (per country) on the development of O&M expenditures over time are given.

Figure 23 O&M expenditure index for road infrastructure for the period 1995-2013

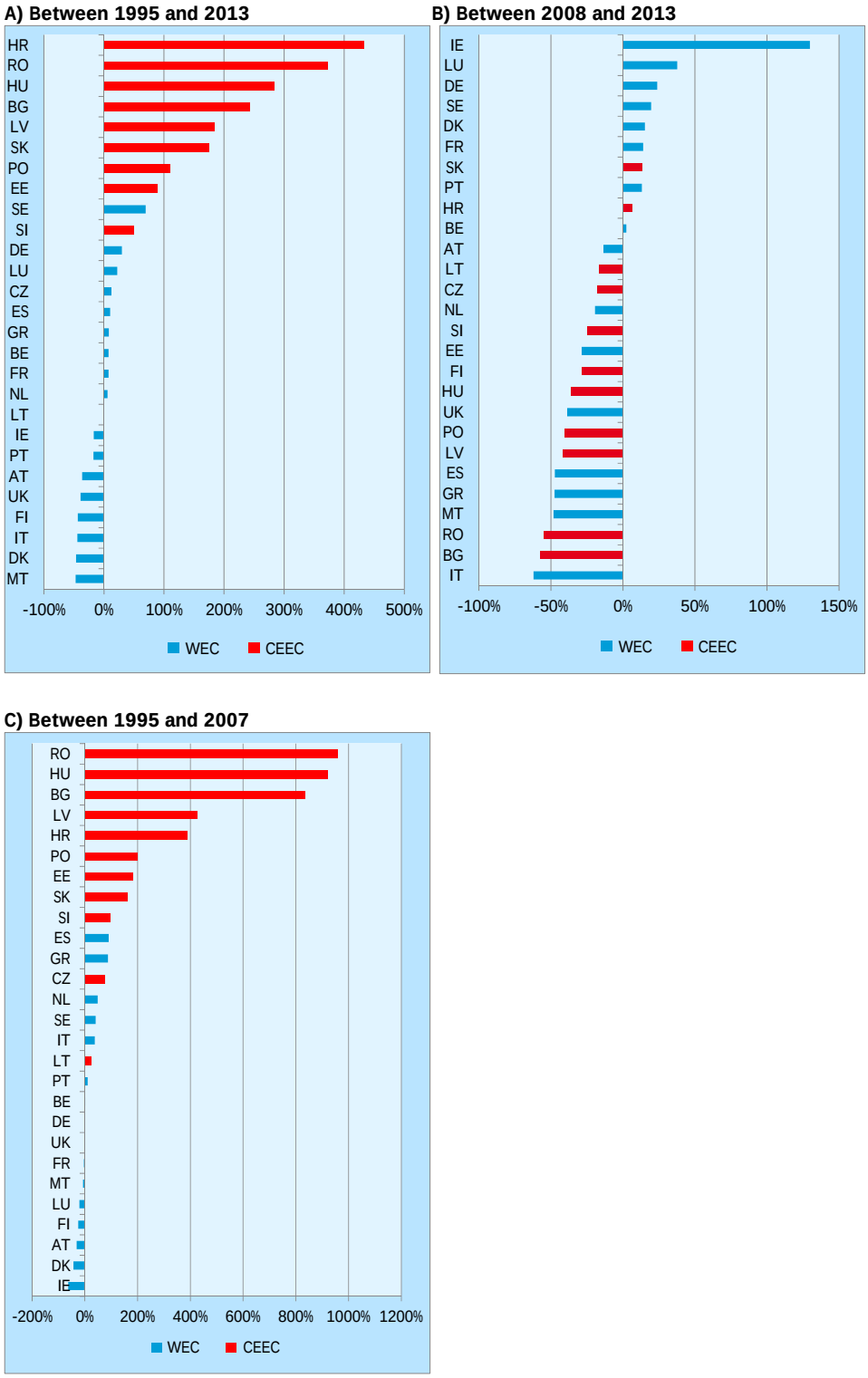


Note: The indices are based on investments in $€_{2013}$.

The sharp increase in O&M expenditures between 1995-2013 (and particularly between 1995 and 2007) is found in every Central and Eastern European country, with the exception of Lithuania (see Figure 24A and Figure 24C). In many Western European countries, O&M expenditures have remained rather stable over time, although there are some countries (Denmark, Italy, Finland, UK and Austria) for which a considerable decrease has been found.

The economic crisis seems to have a significant impact on the O&M budgets in many Eastern and Southern European countries. As is shown in Figure 24B, the O&M expenditures in these countries show a large decrease between 2008 and 2013. According to Steer Davies Gleave (2014), these budget reductions have disproportionately affected local authorities, potentially increasing the gap in road quality between national and local roads. In contrast, in some Western European countries (e.g. France, Sweden, Germany) O&M expenditures have increased over the period 2008-2013. This is, at least partly, explained by governmental programmes aimed to stimulate economic growth by additional investments in road maintenance (e.g. in France several road infrastructure investment plans were implemented to boost economic growth (Steer Davies Gleave, 2014). Finally, the large increase in O&M expenditures for Ireland is probably methodological, as there seems to be a break in 2009 in the statistical data on O&M expenditures (see Annex A.5).

Figure 24 Change in O&M expenditures over time



Concerns are raised in many countries on underfunding road maintenance, leading to a decrease in quality of existing roads and indirectly to negative impacts on the economic competitiveness (ITF, 2013a). This concern could be investigated by comparing actual maintenance expenditures with steady state levels of expenditures, which keep the infrastructure on a long-term good quality level. Data is missing to carry out this analysis for all EU countries, but

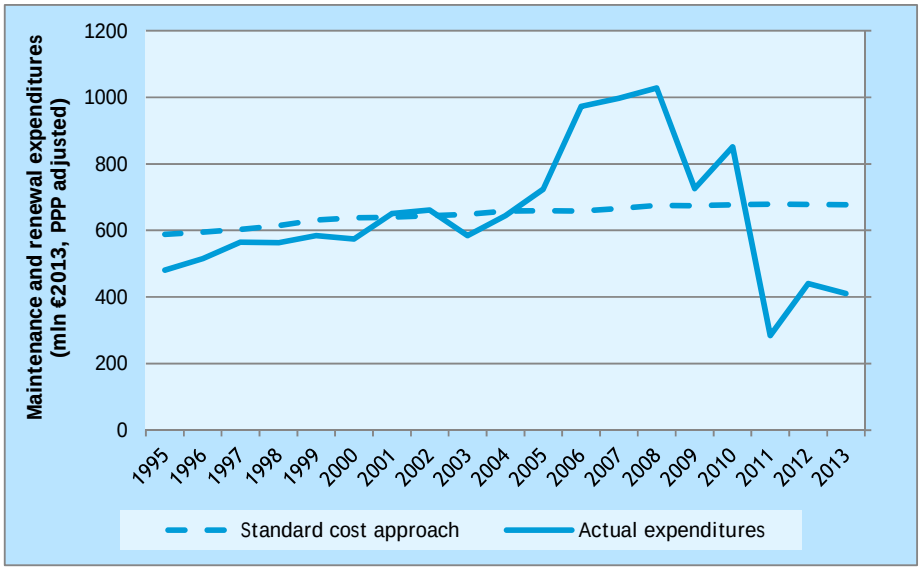
some data is available for Ireland and The Netherlands (see following textbox). For Ireland, a significant risk on underfunding of road maintenance in the coming years is identified by Ireland's Department of Transport. For the Netherlands the data is less conclusive; 2013 expenditures on maintenance and renewal of national roads were far below steady state levels (probably due to the economic crisis), but this was preceded by a period with relatively high expenditure levels.

Steady state level expenditures in The Netherlands and Ireland

The steady state level maintenance and renewal expenditures (i.e. the level of expenditures guaranteeing sufficient long-term quality levels of roads) for national roads in the Netherlands has been estimated based on DVS data (DVS, 2007).

In Figure 25 these steady state level expenditures are compared with actual expenditures over the period 1995-2013. In the period 1995-2005, the actual expenditures were (mostly) below the steady state level expenditures, which could imply an underinvestment in road maintenance. However, in the period 2005-2010 expenditures are significantly above steady state levels, which could probably be explained by recovering overdue maintenance of national roads. In the period 2011-2013 maintenance and renewal expenditures have fallen below steady state levels again (due to the economic crisis).

Figure 25 Comparison of actual and steady state maintenance and renewal expenditures for national roads in the Netherlands

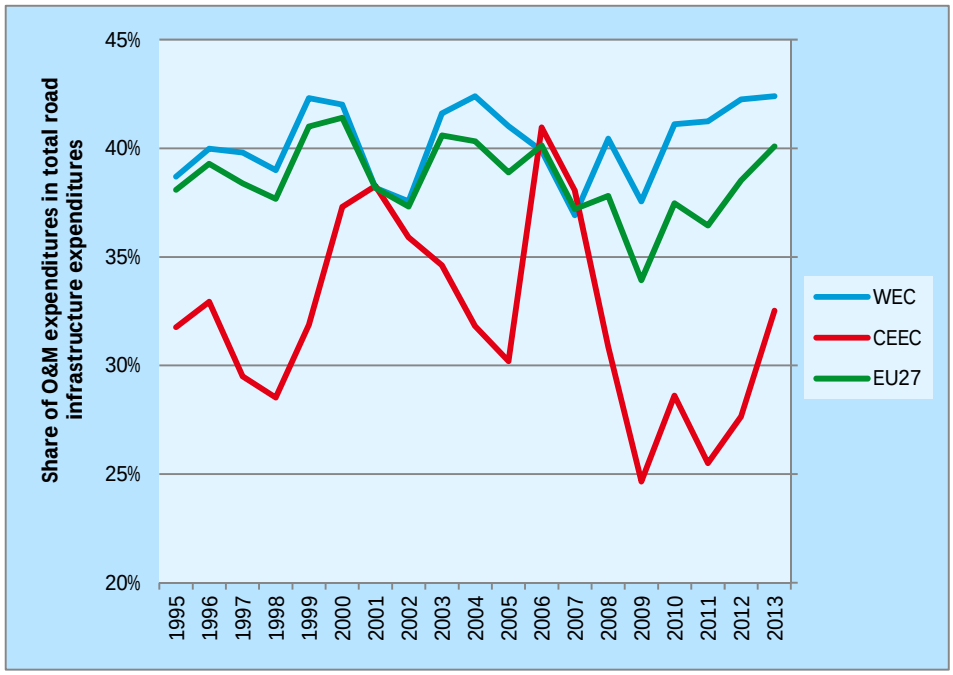


For Ireland, the Department of Transport, Tourism and Sport (2014) estimates the steady state level of maintenance and renewal expenditures for the period up to 2020 on € 1.6 billion per annum. The current budget provides € 1.33 billion per annum (including the budget for investments as well), which is over € 260 million short of the funding required to maintain the existing system in an adequate condition.

Another (less direct) indicator of underfunding of road maintenance is the share of O&M expenditures in total road expenditures. In the EU27, this share has been relatively constant over time: over the last twenty years it has varied between 34% and 41% (see Figure 26). However, the variation in Central and Eastern European countries is much larger than in Western European countries.

In Central and Eastern European countries there seems to have been a long-term increase over the period 1995-2008. However, in 2008 the share of O&M expenditures in total road transport expenditures sharply decreased (particularly in countries like Hungary, Poland and Lithuania). The cut in O&M expenditures has been larger compared to investment expenditures, probably because O&M expenditures are financed from national budgets for a larger extent (as EU funding contributes significantly to the investment budgets in these countries). Furthermore, investment expenditures are planned in long-term projects and can be less easily adjusted, compared to the more short-term planned O&M expenditures.

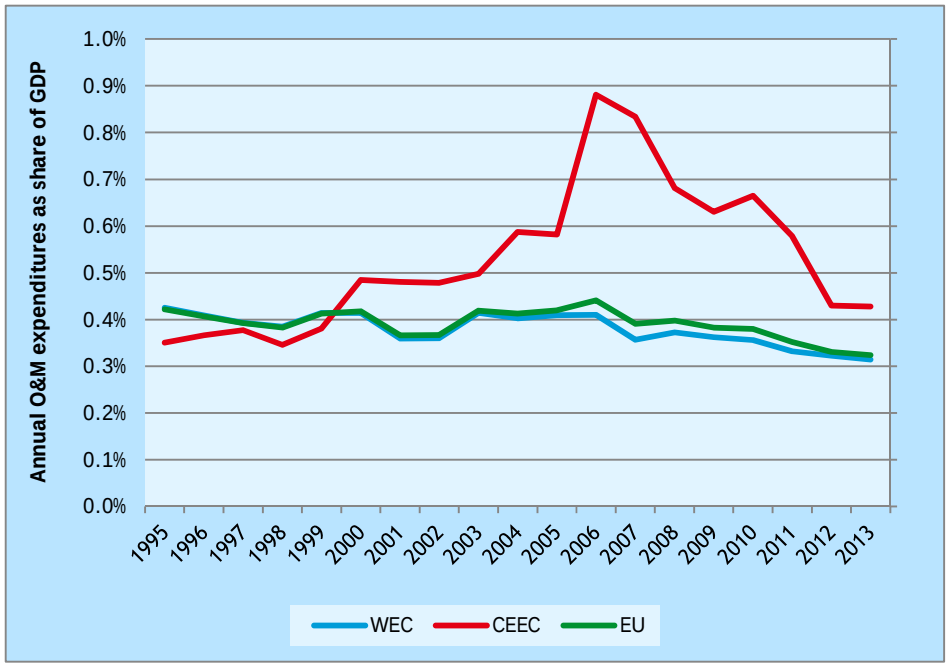
Figure 26 Share of O&M expenditures in total road infrastructure expenditures



3.4.2 O&M expenditures as share of GDP

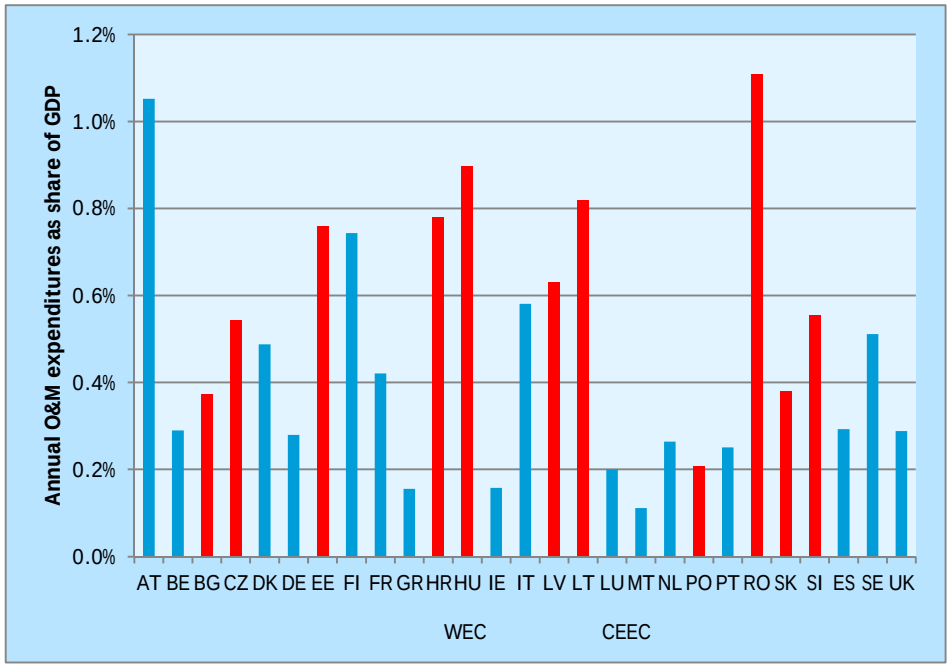
In line with the decreasing share of road infrastructure investments in GDP, the share of O&M expenditures in GDP shows a slowly decreasing trend in the EU27 over the period 1995-2013, mainly explained by the developments in Western European countries (see Figure 27). For Central and Eastern European countries, an increasing trend in the O&M expenditure share is found for the period 1998-2007, showing the rising need for good quality roads in these countries. However, due to the economic crisis, O&M budgets have been heavily cut (Steer Davies Gleave, 2014), resulting in decreasing shares of these expenditures in GDP. More detailed figures (per country) can be found in Annex F.5.

Figure 27 Development in share of O&M expenditures in GDP over time



The higher share of O&M expenditures in GDP in Central and Eastern European countries compared to Western European countries is also shown by Figure 28. As for investments, the share of O&M expenditures in GDP in Romania is slightly higher than in other Central and Eastern European countries.
The inefficiencies in the road infrastructure sector, as discussed in Section 3.3.2, is an important explanation for this finding. For most Western European countries, the share of O&M expenditures in GDP is smaller than or equal to 0.5%, with the exception of Austria, Finland and Italy. Possible explanations for the higher shares in these countries will be discussed in the next section.

Figure 28 O&M expenditures as share of GDP (average shares for the period 1995-2013)



3.4.3 O&M expenditures per kilometre road network length

Figure 29 presents the O&M expenditures per kilometre road network[22] for each EU Member State. These expenditures are highest in Austria, for which there may be several (complementary) reasons. First, the network complexity may be relatively high in Austria due to a rugged landscape and a relatively large number of bridges and tunnels. In Austria, tunnels and bridges make up about 17% of the total length of the main roads, while they only make 1-2% of the networks in countries such as France, Denmark or Ireland (CEDR, 2010). As it costs on average 10 times more to maintain 1 km of bridge (and even more for 1 km of tunnel) than to maintain 1 km of plain road (CEDR, 2010), the high complexity of the Austrian network will be a main reason for the relatively high O&M expenditures. Secondly, the expenditures on winter maintenance of Austrian roads will be above EU average.

Third, the quality of Austrian roads is relatively high (according to WEF (2014), Austria is ranked 6th worldwide with respect to the quality of its road network). And fourth, the traffic density of Austrian (main) roads is relatively high, resulting in relatively high use-dependent O&M expenditures.

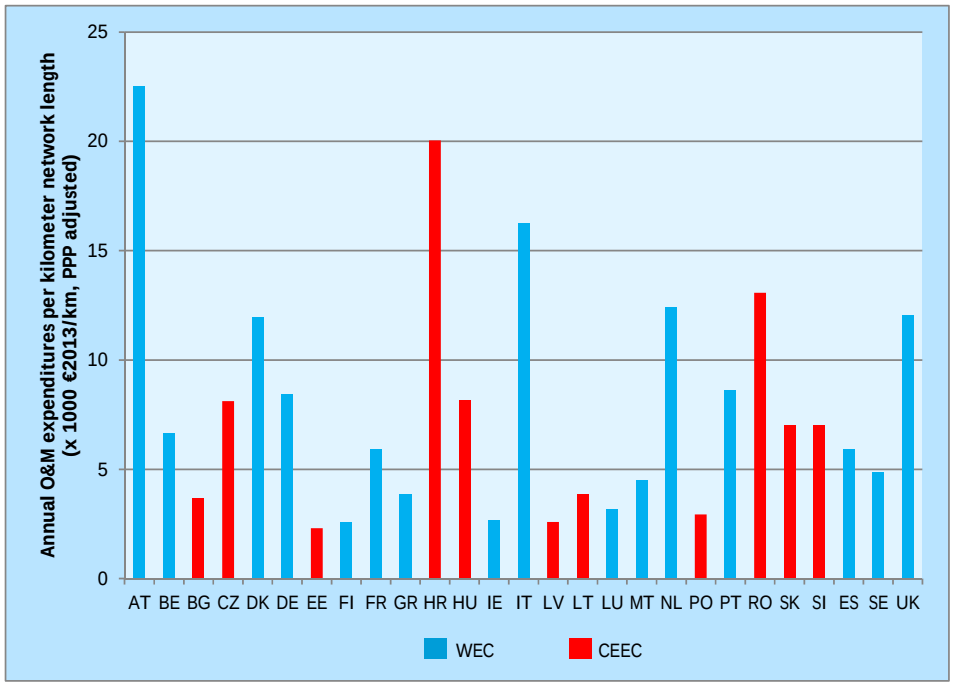
As expected, O&M expenditures per kilometre road network length are relatively high in Croatia and Romania (due to high total O&M expenditures, see Section 3.4.1). High traffic densities and relatively high road quality may be an important reason for the high O&M expenditures on roads in the Netherlands and the UK (and to a lesser extent Denmark).

O&M expenditures on Italian roads are relatively high as well. An important explanation for this finding may be the relatively high level of network complexity in Italy. According to CEDR (2010) about 8% of the length of the main road network in Italy consists of tunnels and bridges.

Finally, the relatively low level of O&M expenditures in countries like Finland, Estonia, Latvia, Lithuania and (to a lesser extent) Sweden is linked to the large share of unpaved roads with very low traffic densities. In these countries the majority of the O&M expenditures are spent on a small share of the total road network, resulting in relatively low average O&M expenditures per kilometre road.

[22] In this study, road network length refer to road length and not lane length. Dual-carriageways are considered one road (i.e. the length of both directions are not summed up).

Figure 29 **Average annual O&M expenditures per kilometre road network length in the period 1995-2013**



3.5 Total infrastructure expenditures

3.5.1 Total road infrastructure expenditures

The total road infrastructure expenditures are the sum of the investments and O&M expenditures. Table 7 presents these total expenditures (PPP adjusted). Both the average annual expenditures in the period 1995-2013 and the expenditures in 2013 are presented. Total expenditures unadjusted for PPP can be found in Annex E.

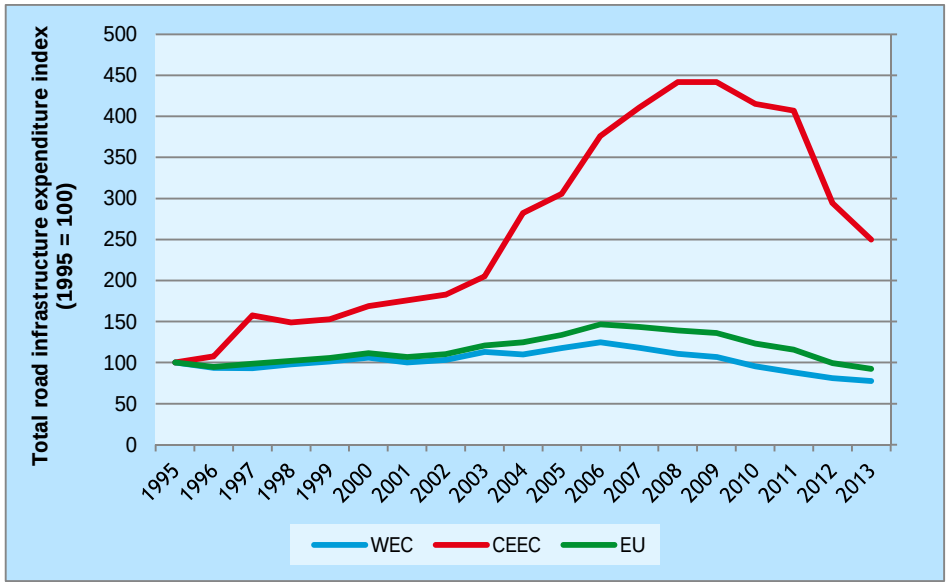
Table 7 **Total expenditures on road infrastructure (mln €$_{2013}$, PPP adjusted)**

Member State	Long-term (1995-2013) average annual expenditures	Expenditures in 2013	Ratio 2013 expenditures/long term average annual expenditures
Austria	4,785	3,761	79%
Belgium	2,597	2,503	96%
Bulgaria	753	994	132%
Czech Republic	3,335	2,268	68%
Denmark	1,716	1402	82%
Germany	15,634	16,219	104%
Estonia	310	312	101%
Finland	1,892	1,689	89%
France	17,218	16,010	93%
Greece	2,688	1,637	61%
Croatia	1,945	1,452	75%
Hungary	2,923	2,208	76%
Ireland	1,543	1,007	65%
Italy	20,127	8,647	43%
Latvia	370	395	107%

Member State	Long-term (1995-2013) average annual expenditures	Expenditures in 2013	Ratio 2013 expenditures/long term average annual expenditures
Lithuania	744	673	90%
Luxembourg	220	243	111%
Malta	50	69	138%
The Netherlands	6,783	6,572	97%
Poland	5,253	4,829	92%
Portugal	3,661	959	26%
Romania	8,442	10,140	120%
Slovakia	968	877	91%
Slovenia	928	413	45%
Spain	13,247	6,917	52%
Sweden	2,184	2,818	129%
United Kingdom	11,379	9,872	87%
EU27	131,696	104,886	80%

The total infrastructure expenditures in 2013 in Europe were about € 105 billion, which is below the long-term average annual expenditure level of about € 130 billion. This decrease in total annual expenditures in road infrastructure expenditures is also seen in Figure 30. This is in line with the separate trends we identified for investments and O&M expenditures. We refer to Section 3.3 and 3.4 for the main explanations for these trends.

Figure 30 Total road infrastructure expenditure index for the period 1995-2013

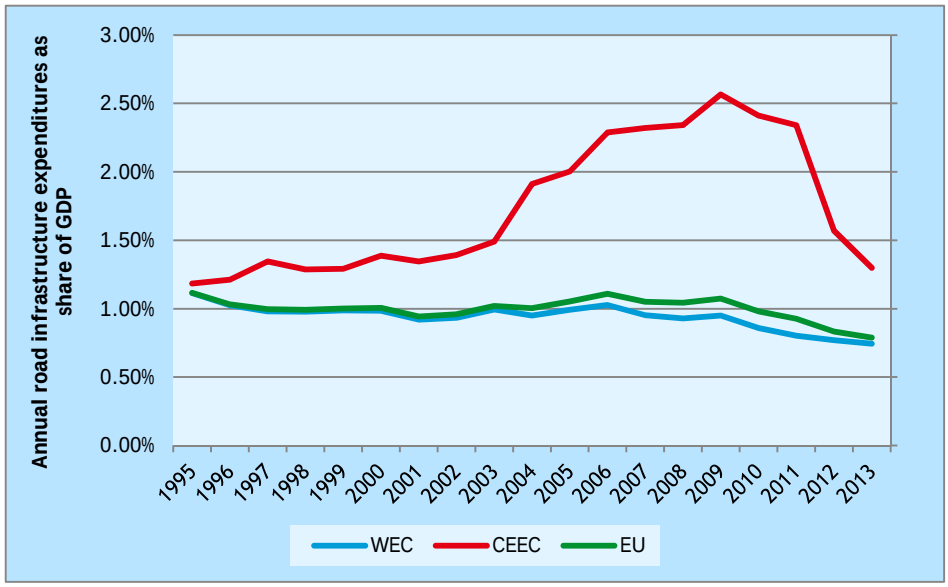


3.5.2 Total infrastructure expenditures as share of GDP

The share of total road infrastructure expenditures in GDP shows a decreasing trend in the EU27 over the period 1995-2013, mainly explained by the developments in Western European countries (see Figure 31). In Central and Eastern European countries, an increasing trend is found for the period 1995-2009 (up to 2.6% in 2009). In the most recent years, road infrastructure

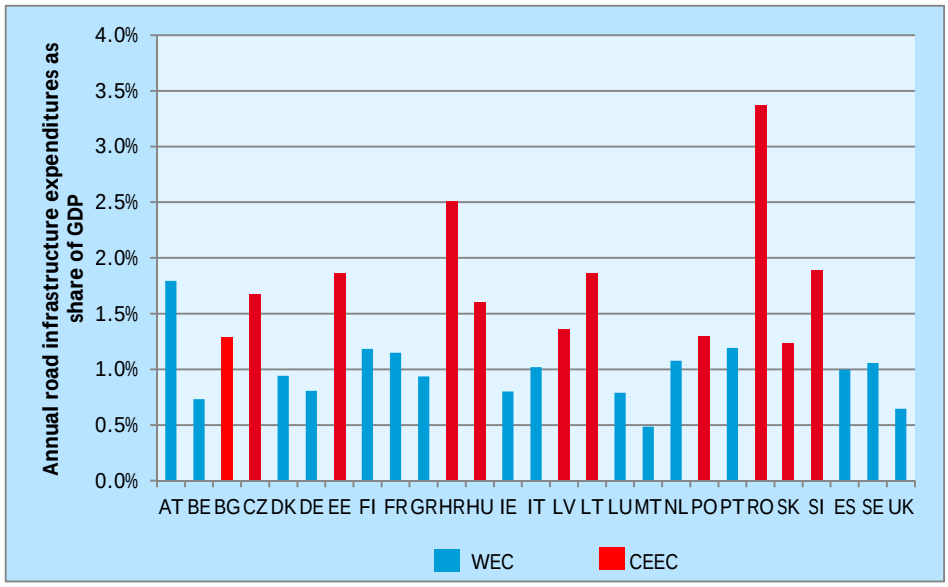
expenditures as share of GDP is decreasing in these countries as well, mainly explained by the economic crisis.

Figure 31 Development in share of total road infrastructure expenditures in GDP over time



As shown by Figure 31 and Figure 32, the share of total road infrastructure expenditures in GDP is higher in Central and Eastern European countries compared to Western European countries. The explanations for this finding were discussed in detail in Sections 3.3 and 3.4.

Figure 32 Total road infrastructure expenditures as share of GDP (average shares for the period 1995-2013)



4 Infrastructure costs

4.1 Introduction

The construction, maintenance and operation of road infrastructure requires significant economic resources, both in terms of capital and labour. In this chapter, we account for the use of these resources by estimating the infrastructure costs of road transport in the EU. The main uncertainties associated to infrastructure expenditures (see Section 1.4 and Annex A) are reflected in infrastructure costs as well. Additionally, uncertainties with respect to the allocation of total infrastructure costs to the various vehicle types should be considered as well.

In this chapter we answer research question 3 and underlying sub questions (see textbox below). To provide the answers to these questions, we first discuss the methodology to estimate infrastructure costs (Section 4.2). Next, the estimated total and average costs are presented for all EU Member States in Sections 4.3 and 4.4.

Research question 3

What are the road infrastructure costs in 2013 in the EU Member States?

This question consists of three sub questions:

1. *How are infrastructure costs estimated based on expenditure data?*
2. *What is the total amount of road infrastructure costs in 2013 in the EU? How can main differences between Member States be explained?*
3. *Which share do the various vehicle categories have in the total infrastructure costs?*

4.2 Methodology to estimate the infrastructure costs

4.2.1 Defining infrastructure costs

Infrastructure costs can be defined as the direct expenses, plus the financing costs or – regarded from a different point of view – the opportunity costs for not spending the resources for more profitable purposes (Fraunhofer-ISI ; CE Delft, 2008). Financing or opportunity costs are expressed by the interest on capital, where the interest rates vary with the legal status of the investor.

In this study we consider four types of infrastructure costs[23]:

- *Enhancement costs:* All costs of new infrastructure or expansion of existing infrastructure with respect to functionality and/or lifetime.
- *Renewal costs*: All costs associated to the renewal of (parts of) the infrastructure. The renewed (parts of) the infrastructure will at least have a lifetime of more than 1-2 years.
- *Maintenance costs:* These costs refer to the costs of 'ordinary' maintenance. These are relatively minor repairs with an economic lifetime of less than 1 to 2 years.

[23] In Chapter 3 enhancement and renewal expenditures are combined as investments and maintenance and operational expenditures as O&M expenditures.

– *Operational costs:* These costs refer to the costs of the organisation of an efficient use of the infrastructure.

Infrastructure costs can be classified by the way they are influenced by the infrastructure usage, i.e. transport volumes. According to this classification, we define the following types of costs (Ecorys ; CE Delft, 2006):

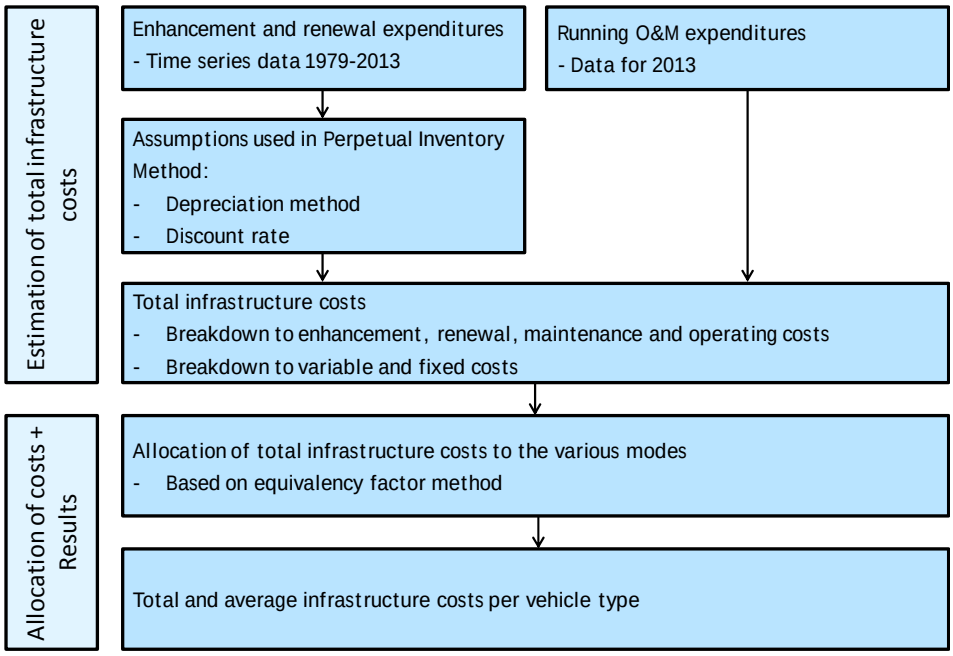
– *Variable costs*: Costs that vary with transport volumes while the functionality of the infrastructure remains unchanged. Part of the maintenance and renewal costs belongs to this cost category.
– *Fixed costs:* Costs that do not vary with transport volumes while the functionality of the infrastructure remains unchanged, or costs that enhance the functionality of the infrastructure. Construction costs and operational costs are examples of fixed infrastructure costs. Also some of the maintenance and renewal costs are (partly) fixed costs[24].

In this study we will use the distinction between variable and fixed infrastructure costs for the allocation of the costs to different vehicle types (see Section 4.2.4).

4.2.2 Estimating infrastructure costs: a general overview

To estimate infrastructure costs, a top-down approach is applied (see Figure 33). First, the total costs of the road network in a country are estimated, based on data on the annual expenditures on road infrastructure (see Chapter 3). These annual expenditures are capitalised to estimate the total infrastructure costs (see Section 4.2.3). In the next step, the total infrastructure costs are allocated to the various vehicle modes by applying relevant cost drivers (based on the so-called equivalency factor method). This is explained in more detail in Section 4.2.4.

Figure 33 General approach to estimate infrastructure costs



[24] E.g. street lighting, traffic signs, etc. (CE Delft, 2008).

4.2.3 Computation of total infrastructure costs

Different methodologies are used to estimate enhancement and renewal costs on the one hand, and operation and maintenance costs on the other hand.

Enhancement and renewal costs

The estimation of both the enhancement and renewal costs is based on the Perpetual Inventory Method (PIM)[25]. The PIM calculates the annual depreciation cost by distributing the initial investments over the lifetime of the infrastructure. In addition to the depreciation cost, interest/financing costs are estimated by using an appropriate interest rate. The sum of depreciation and financing costs equal enhancement and/or renewal costs. The calculation of depreciation and financing costs is illustrated by a simplified example in the textbox below.

Example: calculating investment costs

Assume that in the period 2001–2010 annually € 1,000 is invested in a road and that each investment has an expected lifetime of 10 years. Furthermore, we assume an interest rate of 5%.

To find the total depreciation costs for this road in 2010, we have to sum up the depreciation costs of each individual investment that has not yet been fully depreciated. If we apply a simple linear depreciation approach (constant depreciation rate over the lifetime of the investment), the annual depreciation cost for each individual investment is equal to € 100, and hence the total depreciation costs in 2010 are equal to € 1,000.

To calculate the financing costs, we first have to calculate the economic value of the investments in 2010. The investment done in 2001 has been depreciated for 90%, so its economic value in 2010 is only € 100. By the same reasoning it can be calculated that the economic value in 2010 of the investment done in 2002 is € 200, and so on. The total economic value of the road in 2010 can be found by summing the economic values of the individual investments: € 5,500. By multiplying this total economic value with the interest rate (5%), the annual financing costs in 2010 are calculated. These are equal to € 275.

The total investment costs in 2010 are equal to € 1,000 + € 250 = € 1,250. Compared to the average annual expenditures (€ 1,000), these costs are considerably higher.

The PIM is based on the following assumptions:

- *Depreciation approach:* Different depreciation approaches could be used for the estimation of the enhancement and renewal costs. In this study, we use an annuity approach, which assumes constant annual costs (depreciation + financing costs). Another often used approach is a linear approach, which assumes constant depreciation costs (and hence diminishing total costs). CE Delft (2008) shows that the differences in the results of both approaches are rather limited.

[25] An alternative method to estimate the construction and renewal costs is by assessing future financing needs of the present network (Synthetic method). In this approach, for every type of infrastructure asset, a replacement value, reflecting its dimensioning, load, location and the latest technical standards and specifications, is estimated. Considering the age, past and projected traffic loads, and the physical condition of the asset, depreciation and interest costs are calculated, similar to the PIM approach. As mentioned by Fraunhofer-ISI & CE Delft (2008) and ITF (2013b), the Synthetic Method is more a decision support tool than the PIM approach, as it indicates the amount of money to be raised in order to maintain the quality of the network at a certain level. However, the PIM approach is more closely related to the common philosophy of public accounting and therefore more appropriate to use in this study.

- *Depreciation period:* The period over which the investment costs are depreciated depends on the assumed life expectancy of the infrastructure. In theory, different values of life expectancy should be assumed for the various infrastructure assets (e.g. 10 to 15 years for equipment, 90 to 100 years for earthworks). However, due to a lack of detailed distinction between various infrastructure assets in statistical databases and public accounts, applying different values of life expectancy is not possible. Therefore, we assume an average depreciation period of 35 years, which can be considered as the EU average life expectancy of infrastructure assets[26] (Fraunhofer-ISI ; CE Delft, 2008).
- *Interest rate:* we use an interest rate of 4% for all EU Member States.
- *Inflation correction:* as mentioned in Section 1.3, we express all figures in this report in euro price level 2013. All historic infrastructure expenditures are corrected for inflation. Additionally, figures are adjusted for PPP.

Information on the share of enhancement and renewal expenditures in total investments was available for a few countries (see Table 8). Based on these data, we were able to estimate the average shares of enhancement and renewal expenditures in total investments (75% and 25%, respectively). These were used as default values for the countries for which this data was not available. The distinction between enhancement and renewal costs is needed for the allocation of the investment costs to the various modes (see Section 4.2.4).

Table 8 Long-term average shares of enhancement and renewal expenditures in total investments (averaged over all roads)

Country	Enhancement expenditures	Renewal expenditures
Austria	84%	16%
Netherlands	68%	32%
Poland	70%	30%
Selected default values	75%	25%

Operation and maintenance costs

All the expenditure elements with a lifetime below one or two years (operation, management, minor repairs) are not capitalised according to the PIM approach. Instead, these running costs are taken directly into account when computing total infrastructure costs. This implies that no capitalisation approach is needed for the operation and maintenance costs of transport infrastructure; these can be directly based on the expenditures in 2013.

As mentioned in Section 3.2, maintenance costs would preferably be based on expenditures according to the standard cost approach. Since these expenditures correct for possible under-investments (or over-investments) for infrastructure maintenance, they better reflect the real costs caused by infrastructure users. However, data on expenditures according to the standard cost approach is often not available. In this study we only use maintenance expenditure based on the standard costs approach for the Netherlands. For all other countries we use the actual maintenance expenditures to estimate the maintenance costs.

[26] For road transport, Fraunhofer-ISI & CE Delft (2008) show – based on a review of several European studies - that the average depreciation period of infrastructure assets is approximately 35 years.

For many countries only the total O&M costs are available. To allocate these costs to the various vehicle types, a distinction between operation and maintenance costs is required (see Section 4.2.4). Based on average figures gathered in the EU countries (see Table 9) where most data is available, we were able to estimate default shares of operation and maintenance expenditures in total O&M expenditures (45% and 55%, respectively). These default shares were applied to countries where the data was not available.

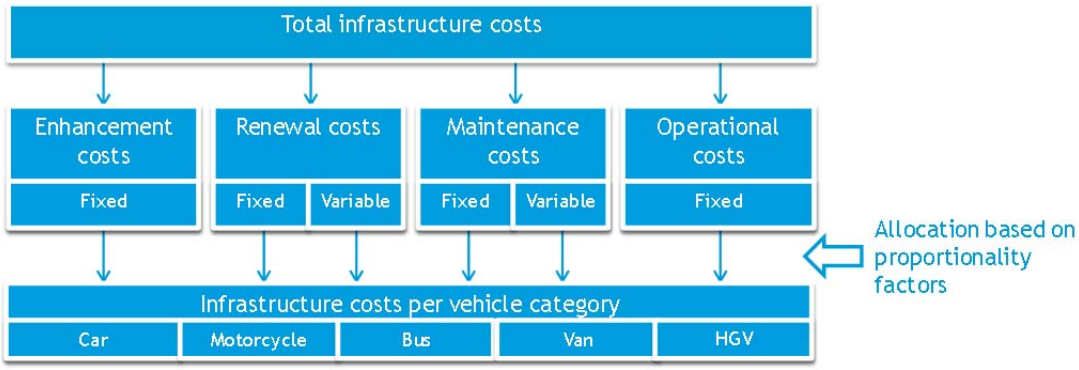
Table 9 Relative shares of operation and maintenance expenditures in total O&M expenditures (averaged over all roads)

Country	Operation	Maintenance
Austria (only motorways)	33%	67%
Germany	48%	52%
The Netherlands	47%	53%
Poland	29%	71%
UK	39%	61%
Selected default values	45%	55%

4.2.4 Allocation of infrastructure costs

The total infrastructure costs are allocated to the various vehicle types, based on the equivalency factor method (see for example (CE Delft; VU, 2014); (ProgTRans/IWW, 2007); (ITS, 2000). This method defines certain proportionality factors (cost drivers) for each vehicle type and cost category which express the responsibility or the causation of the vehicles for the level of total costs (Fraunhofer-ISI ; CE Delft, 2008). This approach is illustrated in Figure 34.

Figure 34 Equivalency factor method



Based on a literature review, the following proportionality factors are defined (for more detailed information, see Annex G):

– *Enhancement costs* are assumed to be 90% capacity dependent, as enhancement of roads is applied once their capacities are too low. These capacity dependent costs are allocated based on Passenger Car Equivalents (PCE) kilometres[27]. The remaining 10% of the enhancement

[27] Indicator measuring the impact that a single vehicle has on traffic variables (e.g. speed, density) compared to a single passenger car.

costs are assumed to be weight dependent (e.g. the type and cost of pavement materials used depends on the assumed number of heavy duty vehicles using the road) and are allocated based on axle load kilometres (4^{th} power rule[28]). Enhancement costs are considered 100% fixed.

- *Renewal costs* are assumed to be partly capacity (40%) and partly weight dependent (60%) as well. Again, the capacity dependent costs are allocated based on PCE kilometres, and the weight dependent costs based on axle load kilometres. Furthermore, based on detailed data for the Netherlands (CE Delft and VU, 2014), it is assumed that 60% of the renewal costs are variable and 40% are fixed.
- *Maintenance costs;* based on detailed data for the Netherlands it is assumed that 30% of the maintenance costs are variable and 70% are fixed. The variable maintenance costs (e.g. road pavement damages) are fully weight dependent and therefore allocated based on axle load kilometres. The fixed maintenance costs (e.g. road signals, maintenance of road sides, etc.) are allocated based on the approach presented by ProgTrans/IWW (2007) for Germany (and also applied by CE Delft (2008) and CE Delft and VU (2014) for the Netherlands): 50% of the costs are allocated based on PCE-kms, 35% based on vehicle kilometres and 15% are allocated to HGVs.
- *Operational costs* are considered fully fixed and are allocated based on vehicle kilometres (30%) and PCE-kilometres (70%).

Table 10 summarises the proportionality factors used to allocate the various infrastructure cost categories.

Table 10 Summary proportionality factors

Cost category	Proportionality factor
Enhancement costs	– PCE kilometres (90%) – 4^{th} power axle load kilometres (10%)
Renewal costs	– PCE kilometres (40%) – 4^{th} power axle load kilometres (60%)
Variable maintenance costs	– 4^{th} power axle load kilometres (100%)
Fixed maintenance costs	– PCE kilometres (50%) – Vehicle kilometres (35%) – Allocated to HGVs (15%)
Operation costs	– Vehicle kilometres (30%) – PCE kilometres (70%)

To allocate the infrastructure costs based on the proportionality factors defined, assumptions have to be made on some vehicle kilometres. The main assumptions are summarised in Table 11.

[28] Based on extensive tests it has been found that road damages are proportional to the 3^{rd} to 4^{th} power of the vehicle's axle load (Doll, 2005). For that reason, weight dependent costs are allocated based on 4^{th} power axle load kilometres. The average axle load of a vehicle depends on its mass, the number of axles and the axle dimension (single, tandem or tridem axles). More specifically, the 4^{th} power axle load is equal to: $\{K_i \times (\frac{A}{10})\}^4$, where A is the actual axle load, i the number of axle groups and K a correction factor for the axle configuration (K = 1 for a single axle, 0.6 for a tandem axle and 0.45 for a tridem axle).

Table 11 Summary of EU average vehicle characteristics

Vehicle type	Passenger Car Equivalent (PCE)	Average mass (ton)	Average number of axles	4th Power axle load
Passenger car	1	1.3	2	3.4×10^{-5}
Motorcycle	0.5	0.4	2	3.2×10^{-7}
Bus	2	15	2	0.6
Van	1.2	2	2	2.0×10^{-4}
HGV	3	15	2.6	0.1

Note: Country specific figures have been applied for average mass of passenger cars and HGVs, and for the number of axles of HGVs (figures shown in this table are EU averages). For the other vehicle characteristics EU average figures have been used. No data on the average number of axles of buses is available. Based on Fraunhofer-ISI and CE Delft (2008), we assumed that buses have two axles. The impact of this assumption on the results are assessed by applying a sensitivity analysis, in which we assume an average number of axles of 2.3. The results of this sensitivity analysis are shown in footnotes 3130 to 32, and 36.

Sources: Fraunhofer-ISI and CE Delft (2008), Eurostat; adaptation by CE Delft.

4.3 Total infrastructure costs

Based on the expenditure data discussed in Chapter 3, we have applied the methodology as discussed in Section 4.2.3 to estimate the total road infrastructure costs. Table 12 provides these costs for the EU Member States in 2013. These costs y are estimated at € 178 billion.[29] The main part of these costs (83%) are fixed, while the remaining part are considered variable.

Table 12 Total infrastructure costs in 2013 (billion $€_{2013}$, PPP adjusted)[a]

Member State	Total infrastructure costs	Fixed infrastructure costs	Variable infrastructure costs
Austria	6.5	5.3	1.2
Belgium	3.9	3.3	0.6
Bulgaria[b]	0.9	0.7	0.2
Czech Republic	4.3	3.6	0.7
Denmark	2.6	2.1	0.5
Germany	28.9	24.1	4.8
Estonia	0.5	0.4	0.1
Finland	2.5	2.1	0.4
France	24.4	20.7	3.7
Greece	3.1	2.6	0.5
Croatia	2.1	1.7	0.4
Hungary[b]	3.9	3.3	0.6
Ireland	2.0	1.7	0.3
Italy	22.4	19.0	3.4
Latvia	0.7	0.6	0.1
Lithuania	1.0	0.8	0.2
Luxembourg	0.35	0.30	0.05

29 The costs of parking places have not been considered for each country in this study, because of a lack of reliable data on expenditure data (see Section 3.2). However, from CE Delft and VU (2014) it is known that the share of the costs of (both on- and off-street) public parking places in total infrastructure costs of road transport is about 17.5%, implying that the total costs of parking places in the Netherlands in 2013 are about € 1.9 billion. Roughly 80% of these costs can be attributed to on-street parking places.

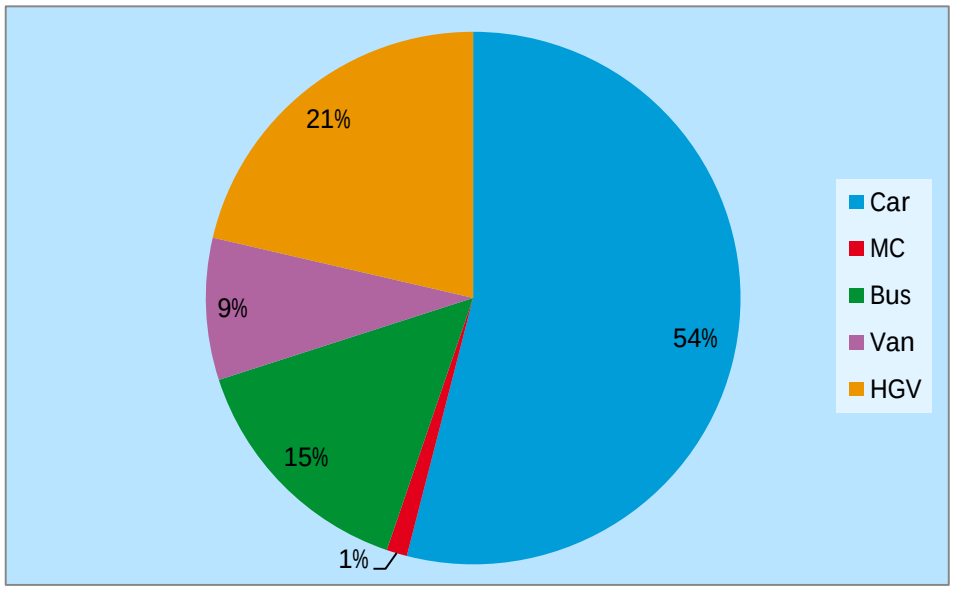
Member State	Total infrastructure costs	Fixed infrastructure costs	Variable infrastructure costs
Malta	0.05	0.04	0.01
The Netherlands	9.1	7.3	1.8
Poland	8.2	7.1	1.1
Portugal	4.6	3.7	0.7
Romania	9.1	7.6	1.5
Slovakia	1.3	1.1	0.2
Slovenia	1.0	0.8	0.2
Spain	17.3	14.1	3.2
Sweden	3.1	2.6	0.5
United Kingdom	14.9	12.1	2.8
EU27	178.4	148.8	29.6

[a] As no reliable data on Cypriot road infrastructure investments was available, no infrastructure costs were estimated for Cyprus.

[b] The infrastructure cost for Bulgaria and Hungary are based on incomplete expenditure data (see Annex A).

About 54% of the total infrastructure costs in the EU are caused by passenger cars, as is shown in Figure 35. This relatively large contribution is explained by the large share passenger cars have in total vehicle kilometres in the EU. HGVs are responsible for about 21% of the infrastructure costs, while busses and vans cause about 15% and 9% of the total costs[30].

Figure 35 Allocation of total infrastructure costs to the various vehicle types

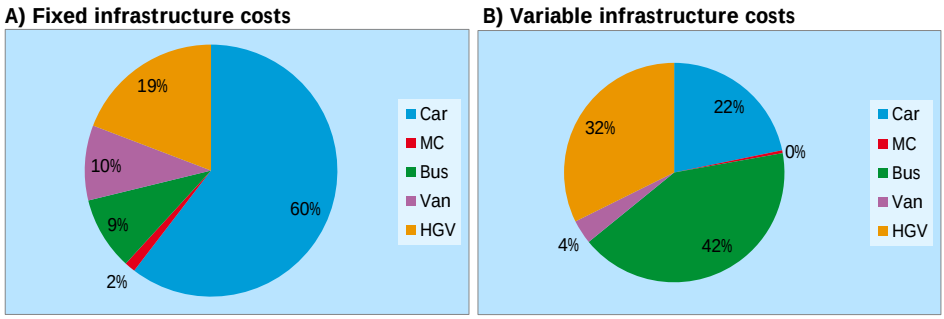


However, if we zoom in on the variable infrastructure costs, we see that HGVs and busses are responsible for the main part of these costs (see Figure 36). This can be explained by the fact that these costs are mainly caused by these

[30] If we assume that busses have 2.3 axles on average instead of 2 (see Section 4.2.4), the share of busses in total infrastructure costs decreases slightly to 13%, while the share of HGVs slightly increases to 21%.

vehicles' high axle loads[31]. The fixed infrastructure costs, on the other hand, are for a large share dependent on capacity (PCE kilometres) and traffic volumes (vehicle kilometres) and hence the major part of these costs are caused by passenger cars.

Figure 36 Allocation of total fixed and variable infrastructure costs to the various vehicle types

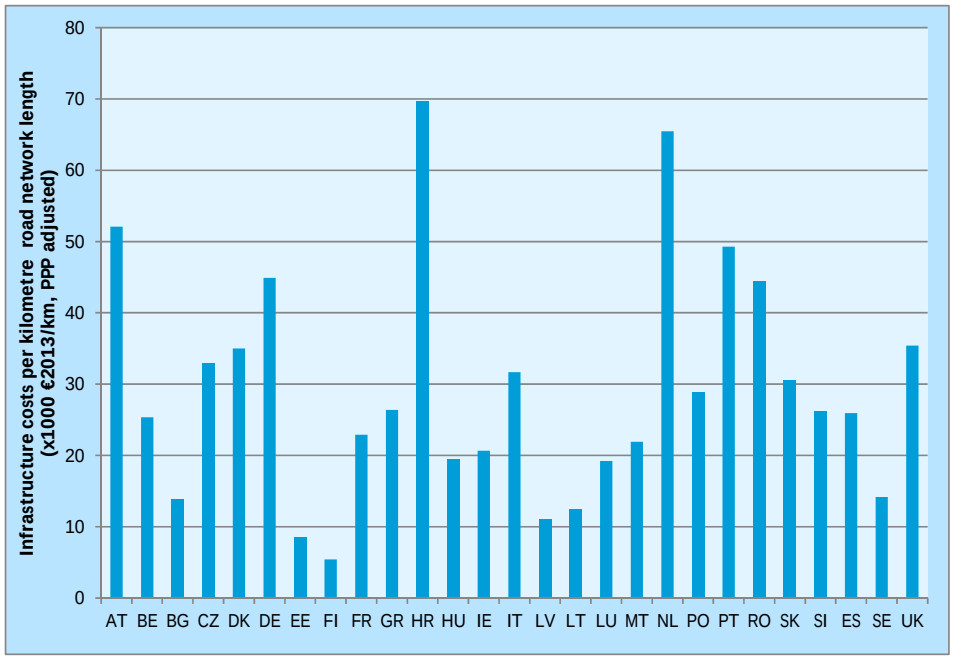


An overview of the estimated total infrastructure costs per kilometre road network is given in Figure 37. For most of the countries, these costs lie between € 15,000 and 30,000 per kilometre road network. For some countries (Estonia, Finland, Latvia, Lithuania and Sweden), the costs are considerably lower, which can be explained by the large share of unpaved and low density roads, for which both investment and O&M costs are very low.
The low infrastructure costs in Bulgaria are (at least partly) explained by the incomplete expenditure data used as input for the infrastructure cost estimations (see Annex A).

There are also some countries (Austria, Germany, Croatia, The Netherlands, Portugal and Romania) for which the infrastructure costs per kilometre road network are significantly higher than € 30,000. For Croatia and Portugal, this may be explained by the large-scale and relatively expensive investment programmes applied over the last twenty years (see Section 3.3.2). Additionally, the replacement of war-damaged road infrastructure may contribute to the high infrastructure costs in Croatia, particularly since this infrastructure was not yet fully depreciated. For Romania, the rather large inefficiencies in the road construction and maintenance sector is considered the main cause of the relatively high infrastructure costs (again see Section 3.3.2). A relatively complex road network (large number of bridges and tunnels), significant winter maintenance and relatively high quality roads are the main reasons for the relatively high infrastructure costs in Austria.
In Germany and the Netherlands, high traffic density combined with high quality levels, explain relatively high infrastructure costs. Furthermore, the high population density in the Netherlands often requires expensive solutions for enhancing or improving the road network.

[31] On average busses have higher axle loads than HGVs and therefore a larger share of the variable infrastructure costs are allocated to busses. The higher average axle loads of busses compared to HGVs is mainly because we assumed that busses only have two axles, while HGVs may have 3, 4 or even 5 axles. In case we assume that busses have 2.3 axles on average (see Section 4.2.4), the share of busses in the variable infrastructure costs decreases to 36%, while the share of HGVs increase to 39%.

Figure 37 Infrastructure costs per kilometre road network length



4.4 Average infrastructure costs

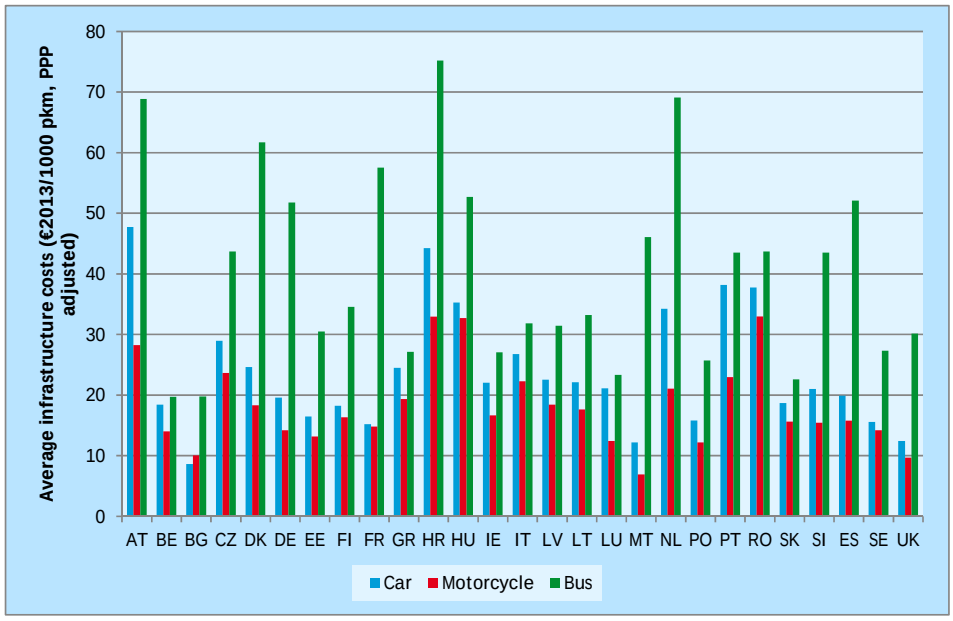
4.4.1 Passenger transport

Figure 38 presents the average infrastructure costs (in € per 1,000 passenger kilometres) for the three passenger modes considered in this study. In all countries, the average infrastructure costs for busses are estimated as the highest, followed by passenger cars and motorcycles[32]. The relatively high infrastructure costs for busses is due to the large share of variable (weight dependent) infrastructure costs caused by these vehicles[33].

[32] If we assume an average number of axles of 2.3 (instead of 2) for busses (see Section 4.2.4), the average infrastructure cost for busses decrease by about 15-20%. Even in that case the average infrastructure costs for busses are estimated to be the highest in most European countries.

[33] The vehicle category 'bus' comprise both (public) busses and coaches. CE Delft and VU (2014) shows that because of their higher average mass (and hence axle loads), coaches have higher average infrastructure costs (in €/vehicle kilometres) than busses in the Netherlands. In terms of €/passenger kilometres, however, average infrastructure costs are higher for busses in the Netherlands, because of the lower occupancy rates of these vehicles.

Figure 38 Average infrastructure costs passenger transport in 2013



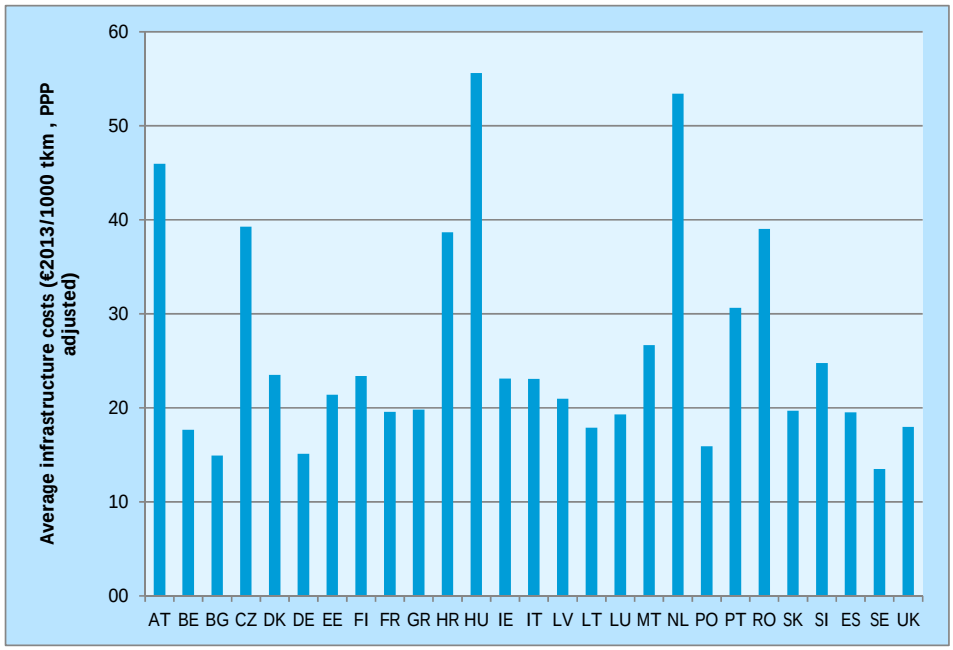
In general, the highest average infrastructure costs for passenger modes are estimated for countries with high infrastructure costs per kilometre road network as well (i.e. Austria, Croatia, Netherlands, Portugal and Romania). The high average infrastructure costs in Hungary are probably explained by the relatively low traffic density on their road network[34]. The high traffic density on the road network in Germany and the UK is an important reason for the lower average infrastructure costs in these countries.

4.4.2 Freight transport

Figure 39 shows the estimated average infrastructure costs (in € per 1,000 tonne kilometre) for HGVs. Again, average infrastructure costs are high in countries with high costs per kilometre road network (i.e. Austria, Croatia, the Netherlands and Romania). The average costs in Hungary and the Czech Republic are relatively high due to the low traffic density on the Hungarian and Czech network and the low estimated average loads of trucks in these countries.

[34] This implies that the total infrastructure costs are allocated to a relatively limited number of passenger kilometers, resulting in higher levels of average costs.

Figure 39 Average infrastructure costs HGVs in 2013

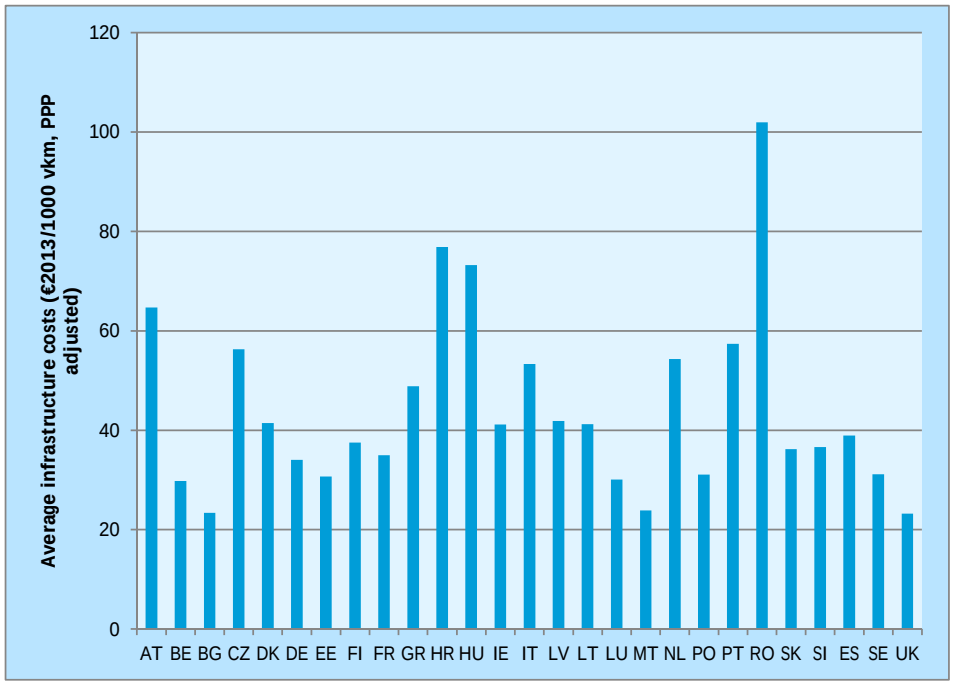


4.4.3 Vans

As vans are often used for services related transport (e.g. by plumbers), the average load of vans relatively low. Expressing the average infrastructure costs in € per 1,000 tonne kilometres would therefore result in very high and meaningless values. Therefore, we decided to express these costs in € per 1,000 vehicle kilometres.

The average infrastructure costs for vans are highest in Romania, Croatia, Hungary and Austria (see Figure 40), which is in line with the results for freight and passenger transport.

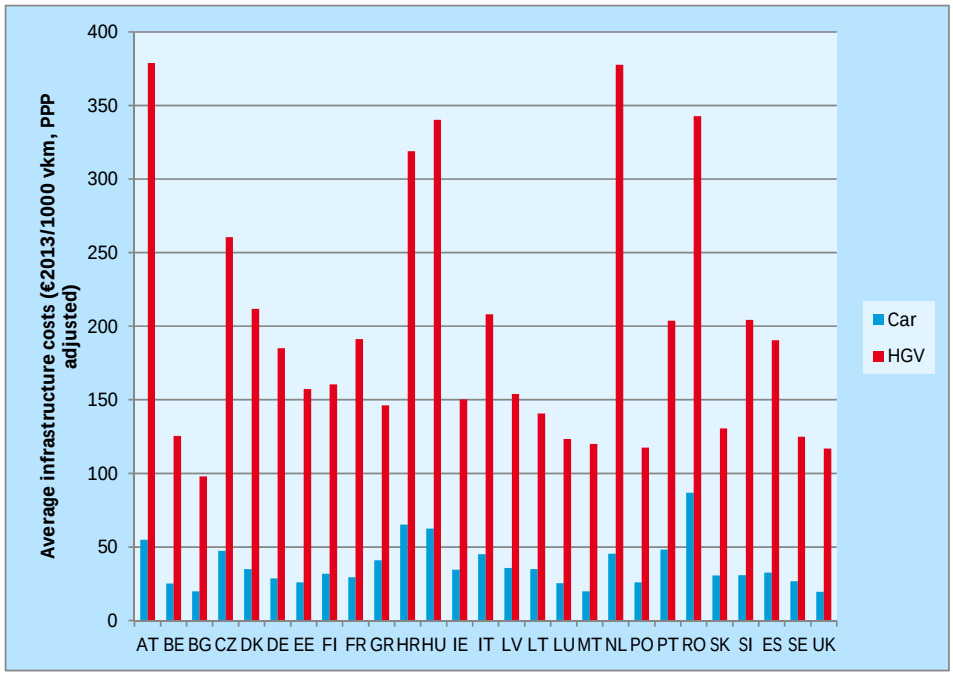
Figure 40 Estimation of average infrastructure costs vans in 2013



4.4.4 Passenger cars vs. HGVs

Figure 37 compares average infrastructure costs of passenger cars and HGVs (both in €/1,000 vkm). In general, the average infrastructure costs for HGVs are considerably higher than for passenger cars (factor 4 to 8). This is explained by the relatively high axle loads of HGVs and hence the large share of weight dependent costs allocated to them.

Figure 41 Comparing infrastructure costs of passenger cars and HGVs



5 Comparison of revenue and costs

5.1 Introduction

This chapter seeks to compare how infrastructure costs caused by road transport compare to the tax/charge revenue they bring in. Firstly, we discuss which perspective should be used to make this comparison (Section 5.2). Secondly, we make the comparison between infrastructure costs and tax/charge revenue by presenting and discussing infrastructure cost coverage ratios, i.e. the share of infrastructure costs covered by tax/charge revenue. We do this both for the road transport sector as a whole (Section 5.2) as for the various vehicle types separately (Section 5.3).

Research question 4

How do the total tax revenue compare to the total infrastructure costs in 2013 in the EU Member States?

This question consists of two sub questions:

1. *From which perspective can tax revenue and infrastructure costs be compared?*
2. *What are the infrastructure cost coverage ratios in 2013 in the various EU countries?*

In this chapter we combine the estimated tax/charge revenue figures estimated in Chapter 2 with the infrastructure cost figures estimated in Chapter 4, implying that we also combine the uncertainties in both types of figures. This causes relatively large uncertainties in the presented infrastructure cost coverage ratios. Particularly the ratios for separate vehicle categories (Section 5.4) are relatively uncertain. But in the end, all ratios have the right order of magnitude and general conclusions are believed to be reliable.

5.2 Different perspectives to compare tax revenue and infrastructure costs

As discussed by Fraunhofer-ISI & CE Delft (2008), there are three different perspectives according to which road tax revenue and infrastructure costs can be compared:

- *Government budget perspective*: this perspective provides the net contribution of the transport sector to the total state budget. Therefore, the total (non-earmarked and earmarked fixed and variable) revenue is compared with total (fixed and variable) costs. This perspective provides insight in whether or not the transport sector is a net contributor to the public sector (as are many other economic sectors).
- *User pay perspective*: this perspective shows whether transport consumers as a group pay for their use of transport infrastructure. In this perspective total (variable and fixed) earmarked revenue is compared to total (fixed and variable) costs. Non-earmarked revenues may be meant to cover external costs or to contribute to the overall funding of the state. Although from a theoretical perspective this approach clearly distinguishes between the contribution the road transport user makes to financing public services in their function as common tax payer (non-earmarked revenue) and the

compensation road users pay for the use of transport infrastructure (earmarked revenue), in reality this distinction is often not made. In several EU Member States with relatively high tax rates (e.g. the Netherlands, Austria) none of the transport tax revenue is specially earmarked for covering road infrastructure. Applying the user pay perspective for these countries can, therefore, result in confusing results. For that reason, we will not apply this perspective in this study.

- *Efficiency perspective*: are changes in the external and infrastructure costs caused by road users covered by changes in taxes and charges? This requires that variable (earmarked and non-earmarked) revenue is compared to variable external costs. This perspective is not focussed on the way the revenue of the taxes and charges are used, but on the way user behaviour can be affected by the taxes/charges. As this perspective is not in line with the objective of this study (to compare total tax revenue and infrastructure costs of road transport), we will not apply it.

As explained above, we will apply the government budget perspective in this study to compare the total tax revenue and infrastructure costs of road transport.

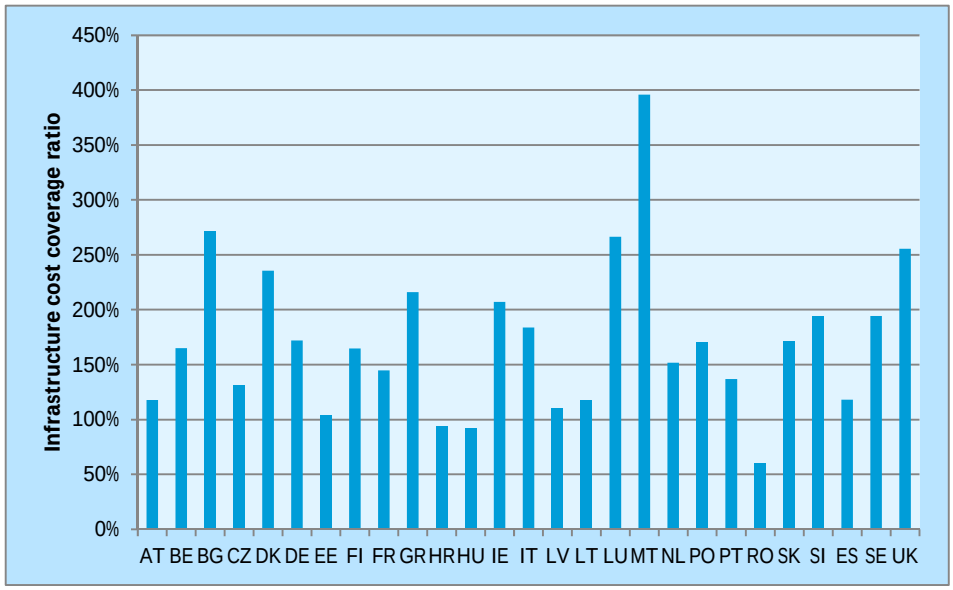
5.3 Infrastructure cost coverage ratio road transport

From the government budget perspective all revenue from specific road transport taxes/charges are compared to total infrastructure costs. As explained in Section 2.2, only the VAT charged on fuel excise duties and registration taxes is considered a transport tax. Therefore, only that share of the VAT revenue is included in the calculation of the infrastructure cost coverage ratios[35].

Figure 42 shows the infrastructure cost coverage ratios for the road transport sector as a whole. In most countries the ratio is larger than 100%, indicating that the tax/charge revenue are higher than infrastructure costs. Exceptions are Croatia, Hungary and Romania. In these three countries infrastructure costs are relatively high, while at the same time the revenue from taxes and charges is moderate. The highest coverage ratios are estimated for Bulgaria, Malta and Luxembourg. The underestimation of the infrastructure costs (partly) explains the high coverage ratio estimated for Bulgaria. For Malta and Luxembourg relatively low infrastructure costs and high tax/charge revenue is the explanation for the high coverage ratio.

[35] Revenues from insurance taxes and company car taxation are not included as well, as they are not considered specific transport taxes (see Section 2.2). Parking charge revenue is not considered as well, because of poor data availability.

Figure 42 Estimated infrastructure cost coverage ratios road transport in 2013

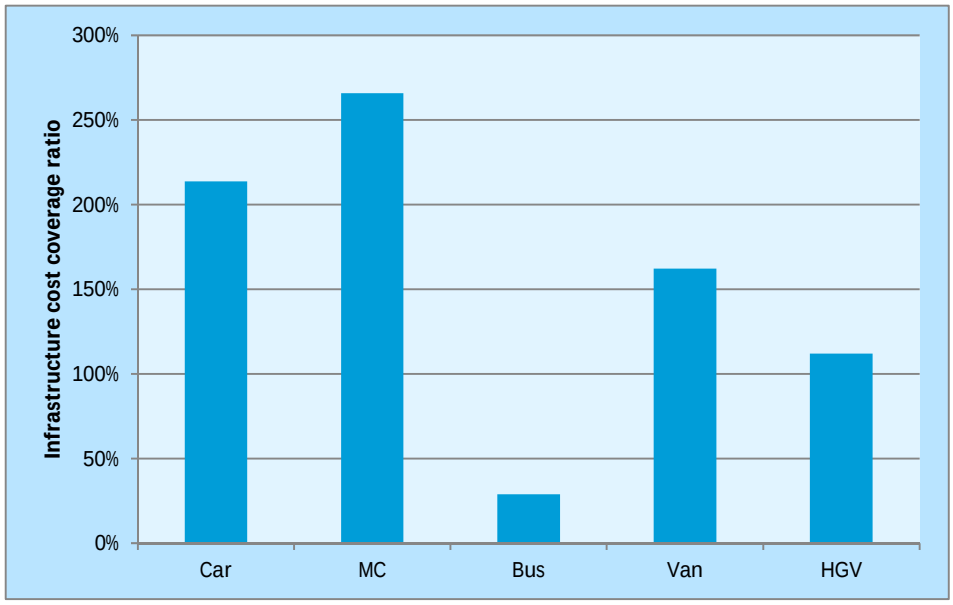


5.4 Infrastructure cost coverage ratios per vehicle type

At EU level, the revenue from taxes and charges is significantly higher than the infrastructure costs for passenger cars, motorcycles, and vans (see Figure 43). For busses, the costs far exceed the revenue, which results from by the significant wear and tear caused by these vehicles[36]. For HGVs, revenue and costs are in the same range (particularly given the uncertainty in the figures estimated). Compared to passenger cars HGVs pay relatively less taxes/charges while they are responsible for a much larger share of the infrastructure costs.

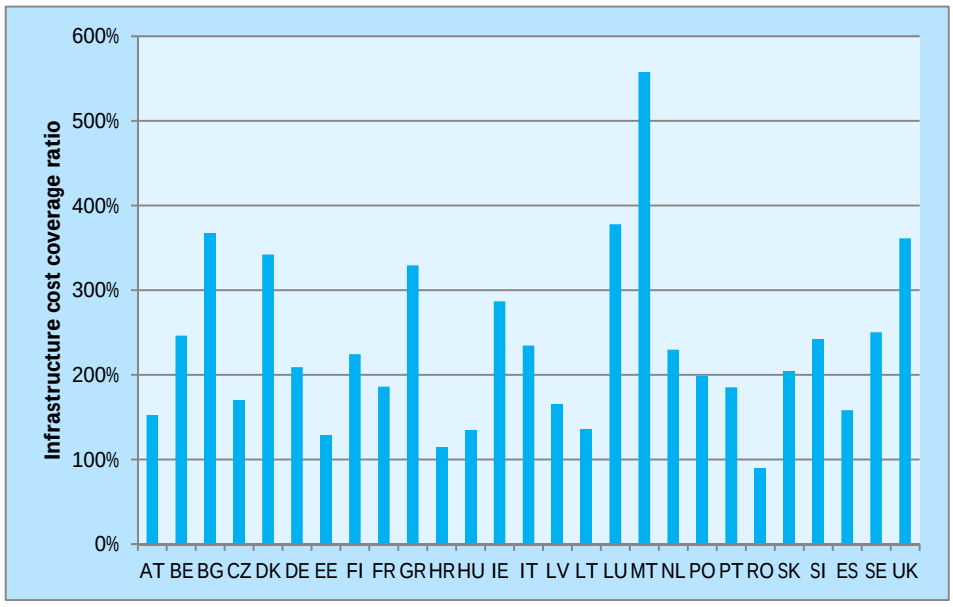
[36] As explained in Section 4.2.4, the average number of axles for busses in the EU28 is uncertain. As this indicator affects the infrastructure cost estimates, we have carried out a sensitivity analysis by assuming that busses have 2.3 instead of 2 axles on average. In that case the infrastructure cost coverage ratio of busses increases slightly (from 29% to 33%), while the ratio for HGVs slightly decreases (from 112% to 102%).

Figure 43 EU average infrastructure cost coverage ratios per mode of transport in 2013



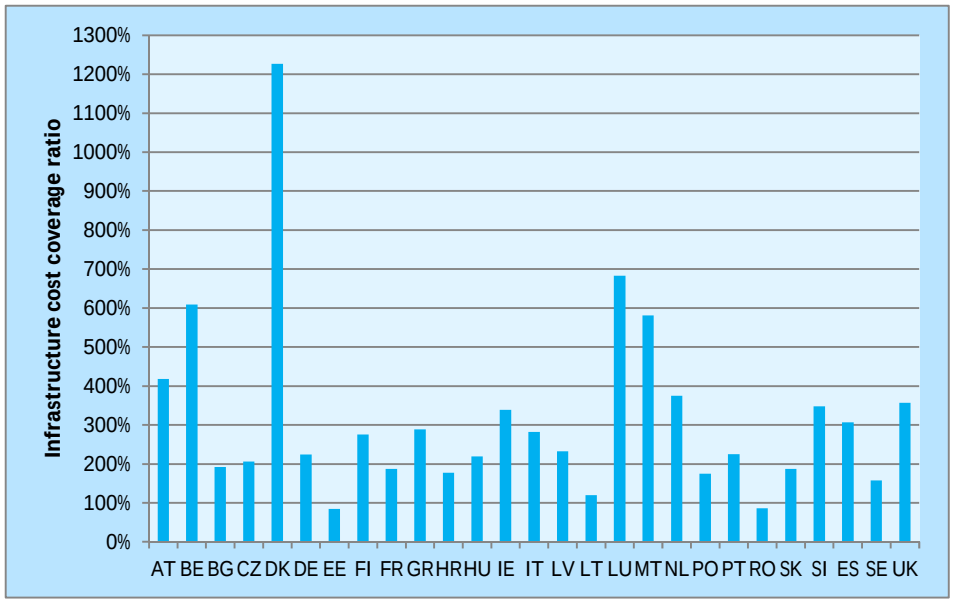
As is shown in Figure 44 the tax/charge revenue from passenger cars is significantly higher than the infrastructure costs in almost all EU countries. An exceptions is Romania, while the ratio in Croatia is just above 100%. Notice that most of the countries with high coverage ratios (Malta, Luxembourg, Greece and Denmark) have relatively high tax revenue per car (and passenger kilometre) as well. An exception is the UK, which' relatively high coverage ratio is mainly due to the relatively low infrastructure costs per passenger car. The relatively high Bulgarian infrastructure cost coverage ratio for passenger cars (and all other vehicle types) is again (partly) explained by the underestimation of infrastructure costs.

Figure 44 Infrastructure cost coverage ratios for passenger cars in 2013



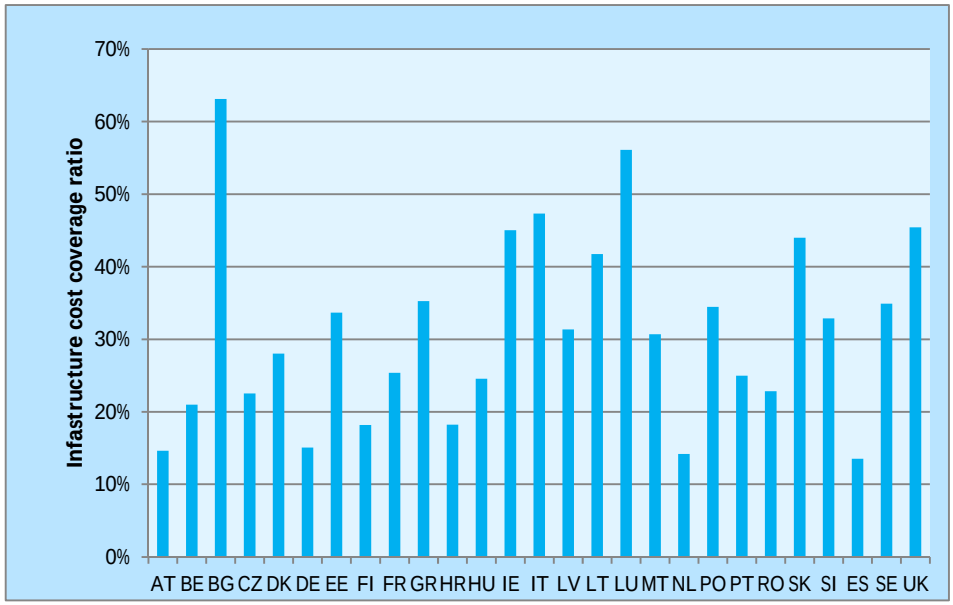
For motorcycles almost all countries have infrastructure cost coverage ratios exceeding 100%, with the exception of Estonia and Romania. The very large infrastructure cost coverage ratio for Denmark is caused by the high registration taxes levied on Danish motorcycles. Also in other countries with high coverage ratios (like Austria, Belgium and Luxembourg) relatively high tax levels are applied on motorcycles.

Figure 45 Infrastructure cost coverage ratios for motorcycles in 2013



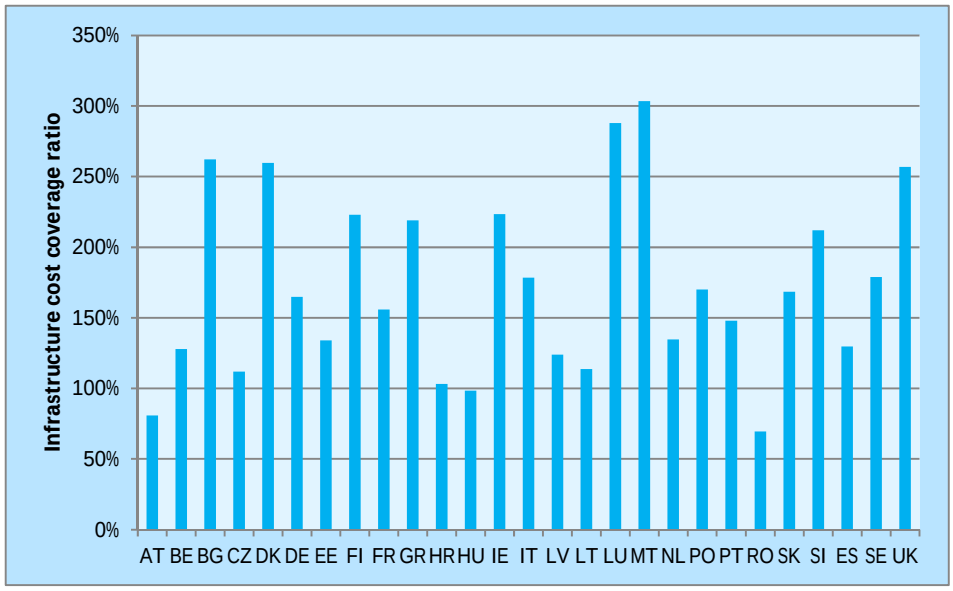
The infrastructure costs of busses are not covered by revenue from taxes and charges. This is mainly due to the relatively high infrastructure costs caused by these vehicles.

Figure 46 Infrastructure cost coverage ratios for busses in 2013



Vans are less heavily taxed than passenger cars, resulting in lower infrastructure cost coverage ratios than for passenger cars (see Figure 47). There are several countries for which infrastructure cost coverage ratios below or near 100% are found (Austria, Czech Republic, Croatia, Hungary, Lithuania, Romania). Most of the countries with relatively high cost coverage ratios apply relatively high tax/charge rates for vans (e.g. Denmark, Finland, Greece and Ireland).

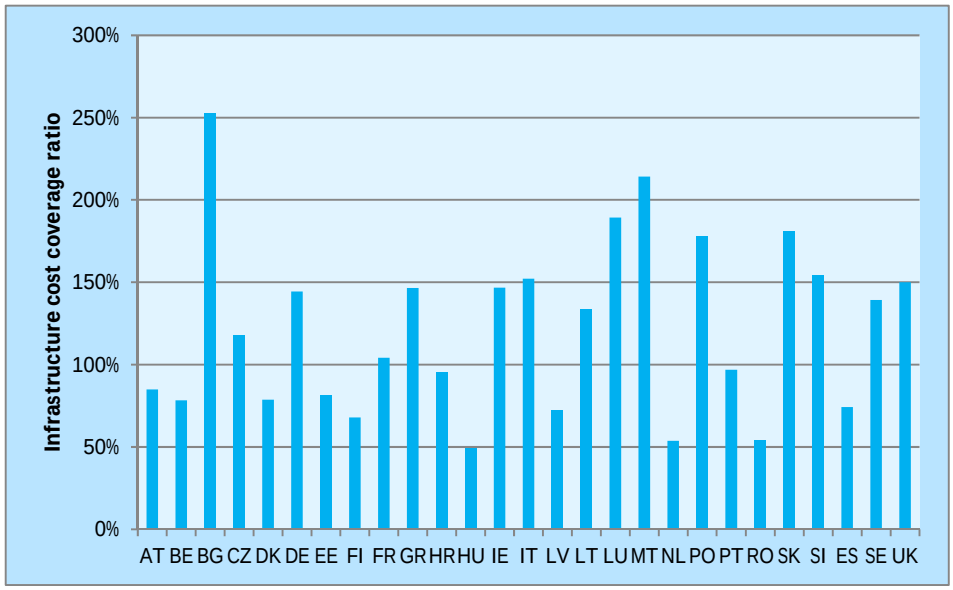
Figure 47 Infrastructure cost coverage ratios for vans in 2013



As is shown in Figure 48 there are many countries where the infrastructure costs of HGVs are not covered by the revenue from taxes and charges.

For thirteen countries, we find cost coverage ratios below or near 100%. In Hungary, the Netherlands and Romania we estimate infrastructure cost ratios of about 50%. Particularly for the Netherlands, this ratio is significantly lower than for other modes, which can be explained by the relatively low tax levels for HGVs in the Netherlands (compared to other modes). Another conclusion that can be drawn from Figure 48 is that in almost all countries that have implemented a (general or HGV-specific) distance-based road charging scheme the infrastructure costs are estimated to be covered by tax/charge revenue (the only exceptions are Austria, Croatia and Portugal, but these are countries with relatively high infrastructure cost levels).

Figure 48 Infrastructure cost coverage ratios for HGVs in 2013



6 Conclusions

6.1 Tax/charge revenue from road transport is higher than infrastructure costs

At EU level, the revenue of road transport taxes and charges exceeded the infrastructure costs in 2013. In only a few countries (Croatia, Hungary and Romania) are the infrastructure costs higher than tax/charge revenue.

Motorcycles and passenger cars have the highest infrastructure cost coverage ratios. Tax/charge revenue of passenger cars is estimated to exceed their infrastructure costs by about 110%, while the revenue coming from motorcycles is about 165% higher than their infrastructure costs. For the heavy duty vehicles (busses and HGVs), infrastructure cost coverage ratios are significantly lower. Busses have coverage ratios that are far below 100% in all EU countries. A large share of the infrastructure cost is attributed to these vehicles, while at the same time average tax/charge levels for busses are relatively low. The infrastructure costs and tax/charge revenue for HGVs are in the same range at the EU level. For several individual countries, however, infrastructure costs significantly exceed tax/charge revenue. In Hungary, the Netherlands and Romania we estimate infrastructure cost coverage ratios of only about 50%, meaning that they are not covering the impact that these vehicles have on the road infrastructure. Particularly for the Netherlands, this ratio is significantly lower than for other modes, which can be explained by the relatively low tax levels for HGVs in the Netherlands.

6.2 Significant contribution road transport to total tax revenue

Road transport significantly contributes to the tax revenue collected in European countries. On average, 5-10% of total tax revenue in EU countries comes from road transport taxes (registration taxes (incl. VAT), ownership taxes, fuel excise duties (incl. VAT)), i.e. € 256 billion. As also the revenue from infrastructure charges (which technically are not tax revenue) is taken into account (about € 30 billion), the total revenue from specific road transport related taxes and charges in 2013 in the EU is about € 286 billion. Additionally, about € 79 billion of revenue from VAT on vehicle and fuel purchases is collected in the EU.

The majority of this revenue is from fuel excise duties (almost half of the revenue). The contributions of the various tax types differ significantly between countries, though. For example, in Denmark vehicle taxes are responsible for almost half of the total road transport tax/charge revenue, while in France more than 20% of the revenue is coming from infrastructure charges.

6.3 Costs of EU road infrastructure are estimated at € 178 billion in 2013

The total road infrastructure costs in the EU are estimated at € 178 billion in 2013. Slightly more than half of the costs are caused by passenger cars (about 54%), even though these vehicles are contributing the majority of the

kilometres on European roads. Also the heavy vehicle categories (HGVs and busses) contribute significantly to the infrastructure costs (about 21% and 15%, respectively).

The average infrastructure costs (in €/vkm) are significantly higher for HGVs compared to passenger cars. Because of the higher axle loads of HGVs, the wear and tear of these vehicles per kilometre driven is much higher than for passenger cars. As busses have relatively high axle loads as well, the average infrastructure costs for these vehicles are also relatively high.

6.4 Road infrastructure expenditures have been severely affected by economic crisis

In the period 1995–2008/2010 infrastructure spending in the EU shows an increasing trend, particularly in Central and Eastern European countries. In the latter countries, the rising need for a good quality infrastructure to support economic development combined with the access to large-scale EU funds, have resulted in high levels of investments and O&M expenditures in the first decade of this century. The share of GDP spent on road infrastructure also increased significantly in these countries, up to 2.6% in 2009. The growth in road infrastructure spending in Western European countries, on the other hand, was modest in the period 1995-2008 compared to Central and Eastern Europe. The share of these expenditures in GDP shows even a decrease over the years in these countries (from about 1.1% in 1995 to about 0.7% in 2013).

As a result of the economic crisis 2008-2013, road infrastructure spending decreased significantly in many European countries since 2007/2008. At the EU level, total annual infrastructure expenditures in 2013 were about € 105 billion, which is well below the long-term average level of € 130 billion.[37] Particularly countries severely affected by the crisis (Southern and Eastern European countries) show a sharp decrease in both investments and O&M expenditures. For example, investment levels in Portugal dropped by about 83% between 2008 and 2013.

6.5 Uncertainties

The quality and availability of data on (particularly) infrastructure expenditures varies significantly between EU countries. Furthermore, no coherent framework exists for accounting infrastructure expenditures, hindering the comparison of these data between countries. For that reason, comparisons between countries should be made very carefully. The data for individual countries and groups of countries is relatively consistent over time, however, such that the identification of trends in infrastructure spending is more reliable.

In general, figures on total revenue and costs are more reliable than figures per mode of transport, as the allocation of total figures to modes does create some additional uncertainties. Furthermore, total revenue and cost figures are more reliable than average ones (expressed in €/vkm, €/tkm or €/pkm), as the latter have to deal with relatively large uncertainties in traffic performance data.

[37] Based on total annual infrastructure expenditures in the period 1995-2013.

The results of this study do contain quite some uncertainties, which have to be kept in mind when interpreting them. Nevertheless, this study provides at least the right order of magnitudes for the various results and hence the general conclusions drawn in the previous sections are considered to be reliable.

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Annex A Data sources and data reliability

A.1 Introduction

In this Annex we describe the data sources used as well as the methodologies applied to estimate any missing data. Additionally, we briefly discuss the main uncertainties in the input data used.

In the remainder of this Annex we first briefly describe the approach followed to identify the level of uncertainty in the various input data used (Section A.2). Next, the data sources and data reliability with respect to taxes and charges (Section A.3), road infrastructure investments (Section A.4), road infrastructure O&M expenditures (Annex A.5), vehicle, passenger and tonne kilometres (Section A.6), road network length (Section A.7), and other input data (Section A.8) are discussed. Finally, we present some recommendations to increase the availability and quality of the input data used in this study (Section A.9).

A.2 Approach to data reliability assessment

In order to assess the reliability of the various input data in a systematic and coherent way, we have developed a qualitative assessment method identifying six categories of uncertainty, ranging from little uncertainty (dark green) to much uncertainty (red) (see Table 13). Based on an expert judgement of CE Delft, all input data used in this study has been assigned to one of these six categories. In this way a good overview of the uncertainties associated to the input data can be given.

Table 13 Reliability assessment methodology

Uncertainty categories	Explanation of uncertainty
	– All data is coming from reliable sources.
	– All data is coming from reliable sources, but other sources present data that do not fully match (and differences can only be partly explained). – Most of the data is coming from reliable sources; only few missing data which has to be estimated based on reliable estimation approach.
	– Data is partly coming from reliable sources and partly estimated based on reliable estimation approach. – Various data sources present different figures (and differences can only be partly explained).
	– Data is partly from reliable sources and partly estimated. Estimation approach used has significant uncertainties. – Various data sources present different figures (and differences cannot be explained).
	– Large data gaps (only small part of the data is available from reliable sources. Main part of the data has to be estimated.
	– All data has estimated (e.g. based on a neighbouring country).

A.3 Taxes and charges

The total revenue from registration taxes, ownership taxes, tolls and vignettes are based on data from the following sources (see also Table 14):

- National data: it includes data from national statistical agencies, Ministries of Finance and/or Transport, road authorities, road charging scheme operators, and car dealer associations;
- Eurostat;
- OECD environmental tax database;
- ASECAP country reports: 2013 versions of these reports were consulted;
- (CE Delft; TML; TNO; TRT, 2012), An inventory of measures for internalising the external costs in transport;
- ACEA Tax Guide 2013.

Table 14 Sources used for the various countries to determine total tax/charge revenue

Data source	Registration tax	Ownership tax	Tolls[a]	Vignettes
National data	AT, BE, DK, FI, GR, HR, HU, IT, LV, MT, NL, PO, SI, ES	AT, BE, CZ, DK, DE, FI, GR, HR, HU, IT, LV, LT, MT, NL, PO, SK, SI, ES, SE, UK	AT, DE, FR, PO, RO, SE, UK	AT, DK, FR, HU, LT, LU, NL, RO, SE
Eurostat	FR, IE, PT, RO, SK			
OECD Environmental tax database		BE, FR, IE, LU		BE, CZ
ASECAP country reports			CZ, DK, GR, HR, IE, IT, NL, PO, PT, SK, SI, ES	SK, SI
CE Delft et al. (2012)		BG, EE, RO		BG
ACEA Tax Guide 2013		PT		

[a] For a few countries we have included the revenue from local toll schemes as well. These are:

- Denmark/Sweden: Store Baelt bridge and Oresund bridge;
- Netherlands: Westerscheldetunnel;
- Romania: Several toll bridges;
- Sweden: Urban road pricing schemes in Stockholm and Gothenburg;
- UK: M6 and London congestion charging.

Only for a few countries data was available on the allocation of total revenue from these taxes and charges to vehicle types. For the other countries this allocation has been made by CE Delft, based on the methodologies described in Section 2.2.

The revenue from fuel excise duties and VAT is estimated using a bottom-up approach:

- *Fuel excise duties*: total transport fuel sales (distinguishing between petrol, diesel and other fuels) in the various EU countries (from Eurostat) are allocated to the various modes. This allocation has been based on the share the various modes have in the country's total energy consumption of road transport. Next, total revenue is estimated by multiplying the fuel sales per mode of transport by the excise duty rates applied in 2013 (European Commission, 2013). Where relevant, corrections have been

made for excise duty refund schemes.

- *VAT on fuel*; the VAT per litre was estimated based on average (country specific) commodity prices (from the T&E fuel tax database) + excise duties (from the EU excise duty tables) and VAT rates (from the EU excise duty tables). Next, total revenue was estimated by using the data on total fuel sales per mode of transport in the various Member States (see above). For busses, vans and HGVs it was assumed that VAT on fuel can be recovered.
- *VAT on new vehicles;* the average VAT per newly sold vehicle was estimated based on average sales prices (from ICCT and ACEA) and VAT rates in the various Member States (ACEA, 2013). By multiplying these figures with the newly sold vehicles in 2013 (from EEA, ACEA) the total VAT revenue are estimated. For busses, vans and HGVs it was assumed that VAT on vehicle purchases can be recovered.

Where possible the results of these bottom-up approaches have been crosschecked with national data.

In the assessment of the reliability of the data on tax/charge revenue a distinction has been made between the data on total revenue (Table 15) and the allocation of these total revenue to the various modes (Table 16).

Table 15 shows that the data on total revenue from registration taxes, ownership taxes and tolls and vignettes is rather reliable. For France no data was available on the revenue of the malus for fuel-inefficient vehicles in the ownership tax, which results in some uncertainty. The uncertainty on revenue from fuel excise duties and VAT on fuel is larger, as these data is estimated using a bottom-up approach. However, crosschecks with national data and data from the EU excise duty tables show that the results are reliable for many countries (indicated by light green). For some other countries such crosschecks did show some (limited) deviations between data sources, resulting in some larger uncertainties (indicated by yellow). Finally, only for a few countries the bottom-up estimates of VAT revenue on vehicle sales have been crosschecked with national data (indicated by light green). For the other countries no data was available to do such crosschecks, resulting in a significant amount of uncertainty.

Table 15 Assessment of reliability of total revenue from taxes and charges

Country	Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on fuel	VAT on new vehicles	Overall reliability
AT							
BE							
BG							
CZ							
DK							
DE							
EE							
FI							
FR							
GR							
HR							
HU							
IE							
IT							
LV							

Country	Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on fuel	VAT on new vehicles	Overall reliability
LT							
LU							
MT							
NL							
PO							
PT							
RO							
SK							
SI							
ES							
SE							
UK							

The allocation of total tax/charge revenue to the various modes is more uncertain than the estimation of total tax/charge revenue data, as is shown by Table 16. Only for a few countries (AT, BE, DK, DE, LU, MT and NL) reliable data was available on this allocation for all (or most) taxes/charges. For the other countries estimations have been made, resulting in varying levels of uncertainty.

Table 16 **Assessment of reliability of allocation of tax/charge revenue to modes**

Country	Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on fuel	VAT on new vehicles	Overall reliability
AT							
BE							
BG							
CZ							
DK							
DE							
EE							
FI							
FR							
GR							
HR							
HU							
IE							
IT							
LV							
LT							
LU							
MT							
NL							
PO							
PT							
RO							
SK							
SI							
ES							
SE							
UK							

A.4 Investments

For the case study countries data on investments in road infrastructure was (partly) based on national data (AT, CZ, DK, DE, FR, IT, NL, PO, ES, SE, UK). Where necessary (and possible) this data was supplemented with data from the International Transport Forum. This source was also used to gather investment data for the other countries. All missing data was estimated by CE Delft, using different types of estimation methods.

As is shown in Table 17, six groups of countries can be distinguished based on the reliability of the investment data available for them:

- For four countries (almost) complete sets of reliable investment data were available (AT, DE, NL and UK).
- For eight countries (BE, DK, FI, FR, IE, IT, LU and SE) data on total investments was available, but a further breakdown (e.g. to enhancement and renewal expenditures) was missing. These data was estimated based on the data for the first group of four countries.
- For another eight countries (CZ, GR, HR, PT, PO, SK, SI and ES) also some data on total investments was missing (e.g. data for urban roads or data for some years). These data was estimated based on (linear) extrapolation or based on cost figures derived from comparable countries. For example, to estimate the investments in urban roads in Czech Republic, the investments per kilometre urban road for Poland were used as a proxy for the Czech Republic. By multiplying this proxy with the total number of kilometres of urban roads in Czech Republic the total investments in Czech urban roads were estimated (taking differences in price level between both countries into account).
- For three countries (HU, LV, LT) a significant part of the data on total investments was missing. These data was estimated based on growth trends in investments in comparable countries. Additionally, investment levels per kilometre urban road network in comparable countries were used to estimate missing data on urban roads investments.
- For Bulgaria and Malta only a small part of the data was available and all other data had to be estimated based on growth trends in comparable countries (for Bulgaria: Poland and Romania; for Malta: Spain).
- Finally, for Estonia no data on investments was available; the data has been estimated based on cost figures from Latvia (expressed in €/km road).

Table 17 Assessment of reliability of data on investments

Country	Reliability data	Country	Reliability data	Country	Reliability data	Country	Reliability data
AT		FI		LV		RO	
BE		FR		LT		SK	
BG		GR		LU		SI	
CZ		HR		MT		ES	
DK		HU		NL		SE	
DE		IE		PO		UK	
EE		IT		PT			

A.5 Operational and maintenance expenditures

The same data sources as for investments have been used to gather data on O&M expenditures. For the case study countries (AT, CZ, DK, DE, IT, NL, PO, ES, SE and UK) national data was used, where necessary supplemented with data from the International Transport Forum. This source was used as main source for O&M expenditures in all other countries as well. All missing data was estimated by CE Delft, using different types of estimation methods.

As is shown in Table 18, six groups of countries can be distinguished based on the reliability of the O&M expenditure data available for them:

- For four countries (almost) complete sets of reliable data on O&M expenditures were available (AT, DE, NL and UK).
- For five other countries (DK, FR, PO, ES and SE) data on total O&M expenditures were available, but without a distinction between operational and maintenance expenditures. This distinction has been made based on the data available from the first group countries.
- For seven other countries (BE, CZ, FI, LV, LT, LU, PT, and SI) an (almost) complete set of data on maintenance expenditures was available, but data on operational expenditures was missing. The latter data have been estimated based on the share operational expenditures have in total O&M expenditures in DE, NL and the UK (for Western European countries) and in Poland (for Central and Eastern European countries). For HU, data on both maintenance and operation expenditures was available, but data on O&M expenditures on urban roads was missing.
  These have been estimated by using Polish expenditure figures per kilometre urban road network (corrected for differences in price level).
- For two countries (HR and SK) not only data on operational expenditures was missing, but also data on O&M expenditures on urban roads. Based on the approaches described above, the missing data for these countries was estimated. For IT, data on O&M expenditures after 2010 was missing; data for 2010 and before was available from ITF statistics. Some data on O&M expenditures in Italy are also presented in the National accounts of the infrastructure and Transport Sector (CNIT), but according to the expert conducting the case study for Italy, these data was incomplete. For that reason data from ITF was preferred.
- This data was estimated by using growth rates from Spain. Finally, for Ireland data on total maintenance expenditures was available, but seems to contain a significant trend break (i.e. in the period 2001-2009 the O&M expenditure figures were far below the long term average figures). We have contacted the International Transport Forum (source of the Irish data), but they couldn't explain these findings. For that reason, the Irish maintenance expenditure data is considered to be relatively uncertain (particularly for the period 2001-2009).
- For three countries (BG, MT and RO) only a small part of the data was available and all other data had to be estimated based on growth trends and unit values (€/km road) from comparable countries (for Bulgaria and Romania: Poland; for Malta: Spain).
- Finally, for two countries (EE and GR) (almost) no data on O&M expenditures was available. For Estonia, the data has been estimated based on cost figures from Latvia (expressed in €/km road). For Greece, data on O&M expenditures in 1995 were extrapolated based on Spanish growth rates.

Table 18 **Assessment of reliability of data on O&M expenditures**

Country	Reliability data	Country	Reliability data	Country	Reliability data	Country	Reliability data
AT		FI		LV		RO	
BE		FR		LT		SK	
BG		GR		LU		SI	
CZ		HR		MT		ES	
DK		HU		NL		SE	
DE		IE		PO		UK	
EE		IT		PT			

A.6 Vehicle, passenger and tonne kilometres

In this study we make use of data on vehicle, passenger and tonne kilometres on national territories, i.e. all kilometres made by national and foreign vehicles on the roads within a specific country. However, in most statistical databases the vehicle, passenger and tonne kilometres for vehicles registered in a country are defined. Data with a national territory scope is only scarcely available and as a consequence the uncertainty in these data is rather large.

For vehicle kilometres the following data sources were used (see also Table 19):

- National statistics, mainly from national statistical agencies;
- Eurostat data; fragmented data is available on vehicle kilometres for some EU countries;
- Data from CE Delft ; INFRAS ; Fraunhofer-ISI, (2011), External costs of transport in Europe; in this study a complete set of vehicle kilometre data is available, but only for 2008;
- TREMOVE; an EU wide transport model providing a complete estimated set of vehicle kilometre data for all modes and all EU countries.

Passenger and tonne kilometres are estimated by multiplying the vehicle kilometres with an average occupancy rate and average load respectively (both differentiated to mode and country). By applying this bottom-up approach a consistent set of vehicle, passenger and tonne kilometres is estimated. The average occupancy rates were preferably based on national data or data from Eurostat. If these data was not available (which was often the case for motorcycles and busses), figures from TREMOVE were used. The same approach has been applied for tonne kilometres.

Table 19 **Sources used for the various countries to estimate vehicle kilometers**

Data source	Car	MC	Bus	Van	HGV
National data	AT, BE, DK, DE, FI, FR, IE, NL, PO, ES*, UK	BE, DK, DE, FR, IE, NL, PO, ES*, UK	BE, DK, DE, FI, FR, IE, NL, PO, ES*, UK	BE, DK, DE, FI, FR, IE, NL, PO, ES*, UK	BE, DK, DE, FI, FR, IE, NL, PO, ES*, UK
Eurostat	CZ*, EE*, HU*, LV*, LT*, MT*, RO*, SI*, SE*	AT, CZ*, HU*, LV*, LT*, MT*, RO*, SI*, SE*	AT, BG, CZ*, EE*, HU*, LT*, MT*, RO*, SK*, SI*, SE*	AT, EE*, LV*, LT*, MT*, SE*	AT, LV*, SE*

Data source	Car	MC	Bus	Van	HGV
CE Delft et al. (2011)	BG*, GR*, HR*, IT*, LU*, PT*, SK*	BG*, EE*, GR*, HR*, IT*, LU*, PT*, SK*	GR*, HR*, IT*, LV*, LU*, PT*	BG*, CZ*, GR*, HU*, IT*, LU*, PT*, RO*, SK*, SI*	BG*, CZ*, EE*, GR*, HU*, IT*, LT*, LU*, PT*, RO*, SK*, SI*
TREMOVE		FI		HR	HR, MT

* For these countries the data source provides only figures for years before 2013 or for part of the network. Therefore, additional estimations have been carried out by CE Delft to estimate the vehicle kilometres in 2013 for the entire network (e.g. by applying growth rates from TREMOVE).

Table 20 shows the results of the reliability assessment of the vehicle, passenger and tonne kilometre data. These results show the relatively large uncertainty in these data, reflecting the limited amount of data available in official statistics. The following groups of countries can be distinguished based on the reliability of the data available for them:

- For nine countries (AT, BE, DK, DE, FI, FR, NL, PO and UK) relatively reliable data on vehicle, passenger and tonne kilometre data is available.
- For one country (IE) reliable data on vehicle kilometres is available, but data on passenger and tonne kilometres is less reliable (occupancy rates for busses and motorcycles and average loads for HGVs were estimated, only occupancy rate figures for bus have been crosschecked).
- For three countries (LV, LT, SE) data on vehicle kilometres have been available from reliable sources (mainly Eurostat) for relatively recent years, but not for 2013. Therefore these data have been extrapolated by CE Delft, resulting in a higher level of uncertainty. The average occupancy rate and load used to estimate passenger and tonne kilometres have been crosschecked.
- For twelve countries (BG, CZ, EE, GR, HU, IT, LU, MT, PT, RO, SK and SI) only relatively old data on vehicle kilometres have been available (mainly from CE Delft et al, 2011), which have been extrapolated by CE Delft. This results in significant levels of uncertainty.
  Average occupancy rates and loads used to estimate passenger and tonne kilometres have only be roughly crosschecked.
- For two countries (HR, ES) a significant part of the data was missing.
  For HR data on vehicle kilometres of vans and HGVs was missing and hence had to be based on TREMOVE data. For Spain, data on vehicle kilometres on urban roads was missing; it was estimated by CE Delft based on data from Fraunhofer-ISI and CE Delft (2008).

Table 20 Assessment of reliability of data on vehicle, passenger and tonne kilometres

Country	vkm	pkm	tkm	Country	vkm	pkm	tkm
AT				LV			
BE				LT			
BG				LU			
CZ				MT			
DK				NL			
DE				PO			
EE				PT			
FI				RO			
FR				SK			
GR				SI			
HR				ES			

Country	vkm	pkm	tkm	Country	vkm	pkm	tkm
HU				SE			
IE				UK			
IT							

A.7 Road network length

In order to compose an accurate set of data on road network length in the various countries, we studied two sources: Eurostat and the 'EU Transport in figures – Statistical pocketbook'. Deviations between these two sources have been studied and explained (for most deviations reasonable explanations have been found, e.g. urban roads or unpaved roads were not covered by one of the sources), and a best estimate of the road network length was made.
Where possible these estimates were crosschecked with data from national statistical agencies.

As is shown in Table 21, for most countries complete and reliable data on road network length was available. For some countries some of the data was missing (e.g. on urban roads) and had to be estimated by combining both sources or by using other sources. For example, for Spain data on urban roads was missing in the data from Eurostat and the EU pocketbook and has been estimated based on Fraunhofer-ISI and CE Delft (2008).

Table 21 Assessment of reliability of data on road network length

Country	Reliability data	Country	Reliability data	Country	Reliability data	Country	Reliability data
AT		FI		LV		RO	
BE		FR		LT		SK	
BG		GR		LU		SI	
CZ		HR		MT		ES	
DK		HU		NL		SE	
DE		IE		PO		UK	
EE		IT		PT			

A.8 Other data

An overview of the remaining input data and the sources from which they are derived is given in Table 22.

Table 22 Overview of data sources

Data	Source
Exchange rates	Eurostat
GDP and GDP/capita	Eurostat
Price Indexes	Eurostat, WBG
PPP figures	Eurostat
Discount rate	Fraunhofer-ISI and CE Delft (2008)
Vehicle fleet	Eurostat
Vehicle characteristics (PCE, axle load, mass)	Eurostat, Fraunhofer-ISI and CE Delft (2008)

A.9 Recommendations to improve data availability and quality

Decreasing the uncertainties in the input data is key to improve the reliability of the results of assessments on road infrastructure costs/expenditures and tax/charge revenue. Particularly the following issues require additional research:

- The development and implementation of a coherent accounting framework for infrastructure expenditures in all European countries would increase the comparability of the expenditure data between countries.
- At the same time big efforts are needed to reduce the number of data gaps with respect to infrastructure spending in the EU. Particularly data on expenditures on urban roads is missing in many countries. Furthermore, detailed data on the breakdown of investments (to enhancement and renewal expenditures) is currently only available for a few countries. Finally, there is a lack of reliable data on operation expenditures on all road types in a significant number of EU countries.
- In many countries it is unknown which share the various vehicle types have in total tax/charge revenue. Improving data on this issue would reduce uncertainties significantly.
- Data on VAT revenue on vehicle sales is not available for most countries. As this data is difficult to estimate, improving data on this issue would significantly improve the reliability of the results.
- It is important to improve the data on traffic performance (vehicle kilometres, passenger kilometres and tonne kilometres) on national territories. These data is currently missing in statistical databases (e.g. Eurostat) for many countries and the data that are provided are fragmented and of low quality.

Annex B Profiles case study countries

B.1 Introduction

In this annex, we present the eleven case study countries as well as some of the main results of the assessments we made for these countries. For each of the countries the development in infrastructure spending over the period 1995-2013 is briefly discussed. Graphical representations of these developments can be found in Annex D.

B.2 Austria

Country analysis: Austria		
National expert	HERRY	
Investments		
Available data on expenditures	*Description of data*	*Data sources*
	– Total investments on all roads for the period 2000-2013	– Statistik Austria
	– Total investments on motorways for the period 1979-2013: • For the period 1997-2013: breakdown of investments to enhancement and renewal expenditures	– 1979-1997: BMWA 1998-2013: ASFINAG
	– Total investments on other main roads (Landesstraßen B) and in other roads (Landesstraßen and Gemeindestraßen) for the periods 1979-2000 and 2002-2006 • For the period 2002-2006: breakdown of investments to enhancement and renewal expenditures was available for other main roads	– 1979-2000: BMWA 2002-2006: Administrations of the 9 Federal Countries
Missing data on expenditures	*Description of data*	*Estimation approach*
	– Total investments on all roads for the period 1979–1999	– Based on available data for motorways, other main roads and other roads
	– Breakdown of total investments on all roads to enhancement and renewal expenditures	– For motorways: for the period 1979-1996 breakdown based on average shares enhancement and renewal expenditures in the period 1998-2013. For main other roads and other roads: breakdown based on average shares enhancement and renewal expenditures have in total investments in main other roads in the period 2002-2006

Country analysis: Austria				
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	1,648	0.6%	4,377	0.035
Development over time in the period 1995-2013	The investments in Austrian roads show a significant increase (in real terms) between 1999 and 2002 (about 60%), which can (at least) partly explained by increased investments in the main road network by ASFINAG. Between 1997 and 2008 the investments done by ASFINAG more than quadrupled (Steer Davies Gleave, 2014). In the period 2002-2009 investments levels in Austria were relatively stable, but a serious drop took place in 2010. Due to the economic crisis investment budgets were cut (e.g. ASFINAG diminished its investments by approximately 25% in 2010 and 2011).			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 2002-2013 – Total O&M expenditures on motorways for the period 1995-2013 • For the entire period an allocation to operational and maintenance expenditures is available – Total O&M expenditures on main roads (Landesstraßen B) for the period 1995-2000 and 2000-2006 – Total O&M expenditures on other roads ((Landesstraßen and Gemeindestraßen) for the period 2000-2006		– Statistik Austria – !998-2013: ASFINAG 1995-1998: BMWA – 1995-2000: BMWA 2002-2006: Administrations of the 9 Federal Countries – Statistik Austria	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 1995-2001 – Total O&M expenditures on main roads in 2001 – Total O&M expenditures on other roads for the period 1995-2000 – Breakdown of total O&M expenditures to operational and maintenance expenditures		– Based on O&M expenditures on motorways, other main roads and other roads – Based on linear interpolation – Based on the same trend in expenditures as for other main roads – For motorways based on available data; for other roads based on average shares in Germany, The Netherlands and the UK	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	2,113	0.017	0.8%	56%
Development over time in the period 1995-2013	The O&M expenditures the main Austrian road network have shown a gradually increasing trend in the first decade of this century, although expenditure levels have been significantly reduced in 2010 and 2011 due to the economic crisis. On the other hand, the O&M expenditures on regional			

Country analysis: Austria				
	and local roads have decreased significantly over the last 20 years, such that the overall O&M expenditures show a decreasing trend since 1998.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue registration tax – Total revenue ownership tax – Total revenue tolls (MAUT) – Total revenue vignettes – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Austrian Ministry of Finance – Austrian Ministry of Finance – ASFINAG – ASFINAG – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	2.0	1.5	3.4	2.7

B.3 Czech Republic

Country analysis: Czech Republic				
National expert	Herbert Seelmann (Brno University of Technology)			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all non-urban roads for the period 1990-2013 – Total investments on motorways for the period 1990-2013		– Transport Yearbook Czech Republic, Ministry of Transport – Directorate of Roads and Motorways (RSD)	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on all roads for the period 1979–2013		– For the period 1990-2013 based on actual/estimated investments on motorways, other roads and urban roads. For the period 1979-1989 estimated based on the same trend as for investments in Poland.	
	– Total investments on all urban roads for the period 1990-2013		– Based on unit investments (in €/km urban road) from Poland.	
	– Breakdown of total investments on all roads to enhancement and renewal expenditures		– Based on shares of enhancement and renewal expenditures in total investments in Poland.	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	1,278	0.6%	3,317	0.025
Development over time in the period 1995-2013	Accessing the European Union in 2004 has boosted the road infrastructure investments in the Czech Republic: investments almost doubled between 2003 and 2005, which is mainly explained by the large contribution of EU funding. Since 2011 investments have fallen, which is at least partly explained by the economic crisis.			
Operating and maintenance costs/expenditures				
Available	*Description of data*		*Data sources*	

Country analysis: Czech Republic				
data on expenditures	– Total maintenance expenditures for the period 1995-2013 – Total O&M expenditures on motorways for the period 2003-2013		– Transport Yearbook Czech Republic – Directorate of Roads and Motorways (RSD)	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 1995-2013 – Total operational expenditures on all roads for the period 1995-2013		– Based on total maintenance and total operation expenditures on all roads for the period 1995-2013 – Based on ratio maintenance expenditures/operation expenditures in Poland in the period 1995-2013	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	990	0.008	0.7%	44%
Development over time in the period 1995-2013	O&M expenditures on Czech roads show the same pattern over time as investments: a sharp increase around 2004 when the Czech Republic joined the EU (and got access to EU funding) and a drop around 2010 (probably explained by the economic crisis).			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue ownership tax – Total revenue tolls (MAUT) – Total revenue vignettes – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Czech Ministry of Finance – ASECAP – OECD Environmental tax database – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	0.3	0.7	4.3	2.3

B.4 Denmark

Country analysis: Denmark		
National expert	Nilsson Production	
Investments		
Available data on expenditures	*Description of data*	*Data sources*
	– Total investments on all roads for the period 1979-2013 – Total investments on urban roads for the period 1979-2013 – Total investments on non-urban roads for the period 1979-2013	– Danish Road Directorate
Missing data on	*Description of data*	*Estimation approach*
	– Breakdown of total investments on	– Breakdown based on the average

Country analysis: Denmark				
expenditures	all roads to enhancement and renewal expenditures		shares enhancement and renewal expenditures have in Austria and the Netherlands	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	746	0.4%	1,937	0.026
Development over time in the period 1995-2013	Investment levels on Danish roads are rather stable over the years (both in absolute terms and as share of GDP), with the exception of the period 2004-2008; in these years investment levels were considerably higher (up to 60%) than the long-term average.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 1995-2013 – Total O&M expenditures on urban roads for the period 1995-2013 – Total O&M expenditures on non-urban roads for the period 1995-2013		– Danish Road Directorate	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Breakdown of total O&M expenditures on all roads to operation and maintenance expenditures		– Based on average shares in Germany, the Netherlands and the UK	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	656	0.009	0.3%	47%
Development over time in the period 1995-2013	O&M expenditures gradually decreased in Denmark (both in absolute terms and as share of GDP). Between 1995 and 2013 the total O&M expenditures on Danish roads was reduced by almost 50%. However, O&M expenditure levels per kilometre road network are still among the highest in Europe and are comparable by expenditure levels in Germany, the Netherlands and the UK.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue registration tax – Total revenue ownership tax – Total revenue tolls (MAUT) – Total revenue vignettes – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Danish Ministry of Finance – Danish Ministry of Finance – ASECAP – Statistics Denmark – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	3.4	0.4	1.6	1.5

B.5 Germany

Country analysis: Germany				
National expert	CE Delft			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all roads for the period 1979-2011 – Total investments on motorways for the period 1979-2011 – Total investments on urban roads for the period 1979-2011 – Total investments on other roads for the period 1970-2011		– Statistisches Bundesamt	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on all roads for the period 2012-2013 – Breakdown of total investments on all roads to enhancement and renewal expenditures		– Estimated based on growth rates in investment data for Germany from International Transport Forum – Breakdown based on the average shares enhancement and renewal expenditures have in Austria and the Netherlands	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	9,340	0.5%	22,002	0.034
Development over time in the period 1995-2013	Road infrastructure investment levels have been rather stable in the period 1996-2013. In real terms, 2013 investments are just below the investment levels of 1996.However, according to Steer Davies and Gleave (2014) a significant (long-term) backlog in road investments exist for roads managed by local authorities.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 1995-2011 – Total O&M expenditures on motorways for the period 1995-2011 – Total O&M expenditures on urban roads for the period 1995-2011 – Total O&M expenditures on other roads for the period 1995-2013 For all roads a breakdown to operation and maintenance expenditures is available for the entire period		– Statistisches Bundesamt	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 2012-2013 – Breakdown of total O&M expenditures on all roads to		– Estimated based on growth rates in O&M expenditure data for Germany from International Transport Forum – Same shares of operation and maintenance expenditures in	

Country analysis: Germany				
	operation and maintenance expenditures for the period 2012-2013		total O&M expenditures as in 2011 are assumed	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	6,879	0.011	0.3%	42%
Development over time in the period 1995-2013	Expenditures on maintenance and operation of the German road network increased notably since 2005, particularly for national roads. Since that year the national policy for the road network is one of 'maintenance before extension', which has led to a significant increase in O&M expenditures. This increase continued after the start of the economic crisis, mainly due to two economic stimulus packages implemented in these years to mitigate the impacts of the economic downturn in Germany.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue ownership tax – Total revenue tolls (MAUT) – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– German Ministry of Finance – Bundesamt für Güterverkehr – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	8.1	4.2	32.4	23.4

B.6 France

Country analysis: France		
National expert	SETEC	
Investments		
Available data on expenditures	*Description of data*	*Data sources*
	– Total investments on all roads for the period 2003-2013	– Ministry of Ecology, Sustainable Development and Energy
	– Total investments on all roads for the periods 1970-1984 and 1987-2002	– International Transport Forum
	– Total investments on tolled motorways for the period 1985-2013 • Breakdown to enhancement and renewal expenditures for the period 2001-2013	– 2007-2013: ASFA annual report 1985-2013: Ministry of Ecology, Sustainable Development and Energy
	– Total investments on national roads (excl. tolled motorways) for the period 1985-2013	– Ministry of Ecology, Sustainable Development and Energy
	– Total investments on urban roads for the period 2003-2013	– Ministry of Ecology, Sustainable Development and Energy

Country analysis: France				
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on all roads for the period 1985-1986 – Breakdown of total investments on all roads to enhancement and renewal expenditures		– Estimated based on linear interpolation – Based on the average shares enhancement and renewal expenditures have in Austria and the Netherlands	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	9,451	0.6%	17,854	0.017
Development over time in the period 1995-2013	In absolute terms, investment levels in France have been rather stable over the period 1995-2013. However, a gradually decreasing trend is shown for investments as share of GDP; between 1995 and 2013 the share of road infrastructure investments in GDP has decreased from almost 0.9 to 0.6%.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 2006-2013		– Ministry of Ecology, Sustainable Development and Energy	
	– Total O&M expenditures on tolled motorways for the period 2005-2013 • Breakdown to operation and maintenance expenditures for the period 2010-2013		– Ministry of Ecology, Sustainable Development and Energy + ASFA + APRR + SANEF	
	– Total O&M expenditures on national roads (excl. tolled motorways for the period 2011-2013 • Breakdown to operation and maintenance expenditures for the period 2011-2013		– Ministry of Ecology, Sustainable Development and Energy	
	– Total maintenance expenditures on national roads (excl. tolled motorways) for the period 1999-2004		– Ministry of Ecology, Sustainable Development and Energy	
	– Total O&M expenditures on urban roads for the period 2003-2013		– Ministry of Ecology, Sustainable Development and Energy	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 1995-2005 – Breakdown of total O&M expenditures on all roads to operation and maintenance expenditures for the entire period		– Estimated based on growth rate of O&M expenditures in Belgium – Based on average shares in Germany, The Netherlands and the UK	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	6,559	0.006	0.3%	41%

Country analysis: France				
Development over time in the period 1995-2013	O&M expenditure levels have been rather stable over the period 1995-2013. In contrast to many other countries, the French national government increased O&M expenditures after the start of the economic crisis to boost economic growth.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue registration tax – Total revenue ownership tax – Total revenue tolls – Total revenue vignettes – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Eurostat – OECD Environmental tax database – URF (2015), Faits et Chiffres 2014 – URF (2015), Faits et Chiffres 2014 – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	2.0	9.8	20.1	13.1

B.7 Italy

Country analysis: Italy				
National expert	TRT			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all roads for the period 2004-2013 – Total investments on all roads for the periods 1970-1984 and 1987-2003 – Total investments on motorways for the period 2008-2013		– CNIT – International Transport Forum – Parliamentary hearing of the Minister of Transport in January 2014	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on all roads for the period 1985-1986 – Breakdown of total investments on all roads to enhancement and renewal expenditures		– Estimated based on linear interpolation – Based on the average shares enhancement and renewal expenditures have in Austria and the Netherlands	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	3,215	0.2%	16,980	0.024
Development over time in the period 1995-2013	Road infrastructure investments in Italy have significantly decreased since the start of the economic crisis: a reduction of about 80% between 2007 and 2013. This decrease in investments affects both national, regional and local roads.			

Country analysis: Italy				
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 1995-2010 – Total O&M expenditures on motorways for the period 2008-2013		– International Transport Forum – Parliamentary hearing of Minister of Transport in January 2014	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 2011-2013 – Breakdown of total O&M expenditures on all roads to operation and maintenance expenditures for the entire period		– Estimated based on growth rate of O&M expenditures in Spain – Based on average shares in Germany, The Netherlands and the UK	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	5,432	0.008	0.4%	63%
Development over time in the period 1995-2013	The expenditures on maintaining and operating Italian roads have decreased since 2007/2008. Maintenance budgets of both the national road operator (ANAS) and of provinces/municipalities were drastically cut due to the economic crisis. This also resulted in a shift from major long-term maintenance projects to minor (and hence less expensive) short-term projects (for national roads). In the longer term this shift may lead to a backlog of road maintenance on Italian roads.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue registration tax – Total revenue ownership tax – Total revenue tolls – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– ACI (2015), Stima del gettito delle principali imposte e tasse gravanti su stra – Same source as for total revenue registration tax – ASECAP – Bottom-up analysis CE Delft – ACI (2015), Stima del gettito delle principali imposte e tasse gravanti su stra ; Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	7.0	6.6	23.3	14.2

B.8 The Netherlands

Country analysis: The Netherlands				
National expert	CE Delft			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all roads for the period 1979-2013 • Breakdown to enhancement and renewal expenditures for entire period. – Total investments on motorways for the period 1979-2013 • Breakdown to enhancement and renewal expenditures for entire period – Total investments on urban roads for the periods 1979-2001 and 2005-2013 – Total investments on other roads for the periods 1979-2001 and 2005-2013		– Calculated by summing up the expenditures on all different types of roads – 2001-2013: Dutch Ministry of Transport – Annual accounts 1985-2000: Statistics Netherlands 1979-1984: CE Delft (1999), Efficiënte prijzen voor het verkeer – 2005-2013: Statistics Netherlands 1985-2001: Statistics Netherlands 1979-1984: CE Delft (1999), Efficiënte prijzen voor het verkeer – Same sources as for urban roads	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on urban and non-urban roads for the period 2002-2004 – Breakdown of total investments on urban and non-urban roads to enhancement and renewal expenditures		– Estimated based on linear interpolation – Based on DVS (2001) and DVS (2007)	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	5,124	0.9%	7,585	0.055
Development over time in the period 1995-2013	Investment levels in the Netherlands have shown a gradually increasing trend between 1995 and 2004 and were remain at a relatively high level in the years afterwards. The high level of investments in recent years may be explained by several large-scale investment projects aimed at widening significant parts of the Dutch motorway network.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 1995-2013 • Breakdown to operation and maintenance expenditures for entire period – Total O&M expenditures on motorways for the period 195-2013 • Breakdown to operation and maintenance expenditures for entire period – Total O&M expenditures on urban roads for the periods 1995-2001		– Calculated by summing up the expenditures on all different types of roads – 2001–2013: Dutch Ministry of Transport – Annual accounts 1995-2000: Statistics Netherlands – Statistics Netherlands	

Country analysis: The Netherlands				
	and 2005-2013 – Total O&M expenditures on non-urban roads for the period 1995-2013		– Statistics Netherlands	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on urban and non-urban roads for the period 2002-2004 – Breakdown of total O&M expenditures on urban and non-urban roads to operation and maintenance expenditures		– Estimated based on linear extrapolation – Based on DVS (2001) and DVS (2007)	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	1,448	0.010	0.2%	22%
Development over time in the period 1995-2013	Expenditures on maintaining and operating the Dutch road network show an increasing trend between 1995-2004. In the period 2005-2012 O&M expenditures slightly decreased (both in absolute terms and as share of GDP), followed by a significant drop in 2013.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total registration tax – Total revenue ownership tax – Total revenue tolls – Total revenue vignettes – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Dutch Ministry of Finance – Dutch Ministry of Finance – ASECAP – RAI/Bovag (2014), Mobiliteit in Cijfers – Dutch Ministry of Finance – RAI/Bovag (2014), Mobiliteit in Cijfers	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	5.6	0.1	6.9	2.1

B.9 Poland

Country analysis: Poland				
National expert	Agnieszka Markowska			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all roads for the period 1987-2013 • Breakdown to enhancement and renewal expenditures for period 2008-2013 – Total investments on motorways for the period 2008-2013 • Breakdown to enhancement and renewal expenditures for entire period		– Total investments: International Transport Forum (crosschecked with data GDDKiA) Breakdown: GDDKiA – GDDKiA	

<table>
<tr><th colspan="5">Country analysis: Poland</th></tr>
<tr><td></td><td colspan="2">– Total investments on urban roads for the period 2008-2009
• Breakdown to enhancement and renewal expenditures for entire period
– Total investments on other roads for the period 2008-2009
• Breakdown to enhancement and renewal expenditures for entire period</td><td colspan="2">– GDDKiA

– GDDKiA</td></tr>
<tr><td>Missing data on expenditures</td><td colspan="2">Description of data
– Total investments on all roads for the period 1979-1986
– Breakdown of total investments on all roads to enhancement and renewal expenditures for the period 1979-2007</td><td colspan="2">Estimation approach
– Estimated based on extrapolation

– Average shares of enhancement and renewal expenditures in total investments for period 2008-2013 are assumed for the period 1979-2007</td></tr>
<tr><td>Key results (in mln €₂₀₁₃, PPP adjusted)</td><td>Total investment expenditures in 2013</td><td>Share of total investment expenditures in GDP in 2013</td><td>Total investment costs in 2013</td><td>Total investment costs per km road in 2013</td></tr>
<tr><td></td><td>4,068</td><td>0.8%</td><td>7,472</td><td>0.026</td></tr>
<tr><td>Development over time in the period 1995-2013</td><td colspan="4">Since 2004 (the year Poland joined the EU), investments on Polish roads have shown a significant increase, in part as result of substantial co-financing from the EU and the World Bank. This support has led to a large-scale programme to significantly increasing the national motorway network. A reduction in EU funding combined with the negative consequences of the economic crisis on the Polish national budget, explains the sharp decrease in investment levels in the most recent years.</td></tr>
<tr><th colspan="5">Operating and maintenance costs/expenditures</th></tr>
<tr><td>Available data on expenditures</td><td colspan="2">Description of data
– Total O&M expenditures on all roads for the period 1995-2013
• Breakdown to operation and maintenance expenditures for the period 2008-2013
– Total O&M expenditures on motorways for the period 2008-2013
• Breakdown to operation and maintenance expenditures
– Total O&M expenditures on urban roads for the period 2008-2009
• Breakdown to operation and maintenance expenditures
– Total O&M expenditures on other roads for the period 2008-2009
• Breakdown to operation and maintenance expenditures</td><td colspan="2">Data sources
– Total expenditures: International Transport Forum
Breakdown: GDDKiA

– GDDKiA

– GDDKiA

– GDDKiA</td></tr>
<tr><td>Missing data on expenditures</td><td colspan="2">Description of data
– Breakdown total O&M expenditures on all roads to operation and maintenance expenditures for the period 1995-</td><td colspan="2">Estimation approach
– Average shares of operation and maintenance expenditures in the period 2008-2013 are applied for the period 1995-2007 as well</td></tr>
</table>

Country analysis: Poland				
	2007			
Key results (in mln €$_{2013}$, PPP adjusted)	Total O&M expenditures/costs in 2013	O&M expenditures per km road in 2013	Share of total O&M expenditures in GDP in 2013	Share of O&M expenditures in total infra expenditures in 2013
	761	0.003	0.2%	16%
Development over time in the period 1995-2013	O&M expenditures on Polish roads significantly increased after the accession of Poland to the European Union in 2004. Supported by EU funding overall road improvements were realised through road maintenance and rehabilitation projects. In most recent years (2012-2013) expenditures levels have significantly fallen, partly explained by cuts in national budgets (due to the economic crisis) and reduced EU funding.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total registration tax – Total revenue ownership tax – Total revenue tolls – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Polish Ministry of Finance – Polish Ministry of Finance – ASECAP; GDDKiA – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	1.0	0.9	11.2	6.8

B.10 Spain

Country analysis: Spain		
National expert	University of Madrid	
Investments		
Available data on expenditures	*Description of data*	*Data sources*
	– Total investments on all roads for the periods 1979-1983 and 1988-2013 – Total investments on tolled motorways for the period 1988-2013 – Total investments on national roads for the period 1988-2013 – Total investments on departmental and regional roads – Total investments on local roads for the period 1988-2013	– Ministerio de Fomento
Missing data on expenditures	*Description of data*	*Estimation approach*
	– Total investments on all roads for the period 1984-1987 – Breakdown of total investments on all roads to enhancement and renewal expenditures for the entire period	– Estimated based on linear interpolation – Based on average shares enhancement and renewal expenditures have in Austria and the Netherlands

Country analysis: Spain				
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	3,951	0.3%	14,332	0.022
Development over time in the period 1995-2013	Over the last 20 years Spain have experienced a road construction boom; since 1991 investment levels have been significantly higher than before, resulting in a growth of the Spanish motorway network by almost 250% (from 4,496 km in 1993 to 11,676 km in 2013). The gradually increasing trend in road investments stopped in 2009; due to the economic crisis, national investment budgets were significantly cut (in 2012 this budget was 98% lower than in 2008), but also severe cuts have been made to local budgets. This reduction may partly reflect a return to long-term spending patterns after a construction boom of two decades.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on tolled motorways for the period 1995-2013		– Ministerio de Fomento	
	– Total O&M expenditures on national roads for the period 1995-2013		– Ministerio de Fomento	
	– Total O&M expenditures on departmental and regional roads for the period 1995-2013		– Ministerio de Fomento	
	– Total O&M expenditures on local roads for the period 2002-2013		– Ministerio de Hacienda y Administraciones Publicas	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 1995-2013		– Based on (estimated) total O&M expenditures on different road types	
	– Total O&M expenditures on local roads for the period 1995-2001		– Same growth rate in O&M expenditures as for departmental roads is assumed	
	– Breakdown total O&M expenditures on all roads to operation and maintenance expenditures for the period 1995-2007		– Based on average shares in Germany, the Netherlands and the UK	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	2,967	0.004	0.3%	43%
Development over time in the period 1995-2013	O&M expenditures on Spanish roads show a sharp increasing trend over the period 1995-2009. However, the review of the road infrastructure spending policies started in 2010 has significantly affected the maintenance budgets, both at national and local scale, leasing to a reduction in O&M expenditure levels. The effect of a falling budget allocation for road network operations is particularly evident for pavement rehabilitation.			

Country analysis: Spain				
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total registration tax – Total revenue ownership tax – Total revenue tolls – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Agencia Tributaria – ANFAC – ASECAP – Bottom-up analysis CE Delft – ANFAC; Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	3.4	1.7	13.0	9.2

B.11 Sweden

Country analysis: Sweden				
National expert	Nilsson Production			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all roads for the periods 1979-1984 and 1987-2013 – Total investments on urban roads for the period 1998-2013 – Total investments on non-urban roads for the period 1979-2013		– 1998- 2013: Statistics Sweden 1987 – 1997: International Transport Forum 1979 – 1984: International Transport Forum – 1998-2013: Statistics Sweden – 2002-2013: Statistics Sweden 1979 – 2001: Statistical Yearbook Sweden	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on all roads for the period 1985-1986 – Breakdown of total investments on all roads to enhancement and renewal expenditures		– Based on linear interpolation – Breakdown based on the average shares enhancement and renewal expenditures have in Austria and the Netherlands	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	1,441	0.6%	1,694	0.008
Development over time in the period 1995-2013	Since the start of this century, investments in the Swedish road network show a constant increasing trend. This trend even continues during the economic crisis.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 2001-2013 – Total maintenance expenditures on all roads for the period 1995-2013 – Total O&M expenditures on urban		– Statistics Sweden – International Transport Forum (ITF) – Statistics Sweden	

Country analysis: Sweden				
	roads for the period 2001-2013 – Total O&M expenditures on non-urban roads for the period 1995-2013		– 2001-2013: Statistics Sweden 1995-2000: Statistical yearbook Sweden	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total O&M expenditures on all roads for the period 1995-2000 – Total operation expenditures on all roads for the period 2001-2013 – Total operation expenditures on all roads for the period 1995-2000		– Based on total operation and total maintenance expenditures for the period 1995-2000 – Difference between total O&M expenditures from Statistics Sweden and total maintenance expenditures from ITF – Based on same growth rate as for total maintenance expenditures	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	1,377	0.006	0.3%	49%
Development over time in the period 1995-2013	The expenditures on maintenance and operation of Swedish roads show an increasing trend over the last 15 years. In contrast to neighbouring countries like Denmark and Finland, the O&M expenditures as part of GDP did not significantly fall over the last 15 years, but remained rather constant.			
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue ownership tax – Total revenue tolls – Total revenue vignettes – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Swedish Ministry of Finance – Swedish Ministry of Finance – Swedish Ministry of Finance – Bottom-up analysis CE Delft – Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	1.0	0.2	3.9	2.7

B.12 UK

Country analysis: UK				
National expert	CE Delft			
Investments				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total investments on all roads for the periods 1979-1984 and 1987-2013 – Total investments on motorways + trunk roads for the period 1987-2013		– Department for Transport	
Missing data on expenditures	*Description of data*		*Estimation approach*	
	– Total investments on all roads for the period 1985-1986 – Breakdown of total investments on all roads to enhancement and renewal expenditures		– Based on linear interpolation – Breakdown based on the average shares enhancement and renewal expenditures have in Austria and the Netherlands	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total investment expenditures in 2013*	*Share of total investment expenditures in GDP in 2013*	*Total investment costs in 2013*	*Total investment costs per km road in 2013*
	6,400	0.3%	11,425	0.027
Development over time in the period 1995-2013	Annual investments on the UK road network have significantly fall between 1991 and 1997 and remained rather stable at this low level over the years afterwards. The relatively low investment levels in the UK have resulted in one of the most dense European truck road network, particularly since no considerable road expansion has taken place over the past 10 years.			
Operating and maintenance costs/expenditures				
Available data on expenditures	*Description of data*		*Data sources*	
	– Total O&M expenditures on all roads for the period 1995-2013 • Breakdown to operation and maintenance expenditures for the entire period – Total O&M expenditures on motorways + trunk roads for the period 1995-2013 • Breakdown to operation and maintenance expenditures for the entire period		– Department for Transport	
Missing data on expenditures	*Description of data*		*Estimation approach*	
Key results (in mln €$_{2013}$, PPP adjusted)	*Total O&M expenditures/costs in 2013*	*O&M expenditures per km road in 2013*	*Share of total O&M expenditures in GDP in 2013*	*Share of O&M expenditures in total infra expenditures in 2013*
	3,473	0.008	0.2%	35%
Development over time in the period 1995-2013	Road operation and maintenance expenditures in the UK varied slightly over the period 1995-2010. Since 2010 maintenance budgets have fallen by almost 40%. Local budgets (making up 70 to 80% of all road maintenance expenditures in the UK) are under pressure from growing spending trends in social care and environmental services.			

Country analysis: UK				
Revenue from taxes and charges in 2013				
Available data	*Description of data*		*Data sources*	
	– Total revenue ownership tax – Total revenue tolls – Total revenue fuel excise duty – Total revenue VAT on fuel and vehicle sales		– Department for Transport Statistics (only figures for Great Britain available) – ASECAP; Transport for London – Bottom-up analysis CE Delft – ONS Family spending report 2014; Bottom-up analysis CE Delft	
Key results (in bln €$_{2013}$, PPP adjusted)	*Total revenue vehicle taxes*	*Total revenue infrastructure charges*	*Total revenue fuel excise duty*	*Total VAT revenue*
	4.7	0.3	28.8	12.2

Annex C Tax revenue not adjusted for PPP

In Table 2 (Section 2.4) the total road tax revenue in the EU27 Member States in 2013 are presented (figures for Cyprus can be found in the textbox below that table). These figures are adjusted for PPP. The unadjusted figures can be found in Table 23.

Table 23 Total revenue from road taxes/charges in the EU in 2013 (billion €$_{2013}$)

Member State	Registration tax	Ownership tax	Tolls and vignettes	Fuel excise duty	VAT on registration taxes	VAT on fuel excise duty	VAT on vehicle purchase	VAT on fuel	Total (incl. VAT on	Total (incl. all VAT)
Austria	0.5	1.8	1.7	3.8	0.1	0.6	1.5	0.9	**8.5**	**10.8**
Belgium	0.5	1.7	0.1	4.2	0.1	0.6	1.3	0.9	**7.2**	**9.4**
Bulgaria	-	0.1	0.1	0.9	-	0.1	0.1	0.3	**1.2**	**1.6**
Cyprus	0.0	0.1	0.0	0.3	0.0	0.0	0.0	0.1	**0.5**	**0.6**
Czech Republic	-	0.2	0.5	2.9	-	0.4	0.6	0.6	**4.0**	**5.1**
Denmark	2.7	1.9	0.6	2.1	0.6	0.4	0.7	0.5	**8.2**	**9.3**
Germany	-	8.5	4.4	34.0	-	5.1	13.1	6.4	**52.0**	**71.5**
Estonia	-	0.0	-	0.3	-	0.0	0.1	0.1	**0.4**	**0.6**
Finland	0.9	0.9	-	2.5	0.2	0.4	0.3	0.3	**4.9**	**5.5**
France	2.0	0.2	11.1	22.8	0.3	3.0	7.1	4.3	**39.4**	**50.9**
Greece	0.1	1.2	0.5	3.4	0.0	0.5	0.1	0.6	**5.8**	**6.5**
Croatia	0.0	0.0	0.3	0.8	0.0	0.1	0.1	0.3	**1.3**	**1.7**
Hungary	0.1	0.1	0.2	1.6	0.0	0.3	0.3	0.5	**2.2**	**3.0**
Ireland	0.5	1.1	0.2	2.3	0.1	0.3	0.3	0.4	**4.5**	**5.2**
Italy	1.3	5.7	6.7	23.5	0.3	4.0	5.6	4.6	**41.5**	**51.6**
Latvia	0.0	0.1	-	0.4	0.0	0.0	0.1	0.1	**0.5**	**0.6**
Lithuania	-	0.1	0.0	0.6	-	0.1	0.1	0.2	**0.8**	**1.0**
Luxembourg	-	0.1	0.0	0.9	-	0.1	0.2	0.2	**1.1**	**1.4**
Malta	0.0	0.0	-	0.1	0.0	0.0	0.0	0.0	**0.2**	**0.2**
Netherlands	1.2	5.0	0.2	7.6	-	0.8	0.5	0.8	**14.7**	**16.2**
Poland	0.3	0.2	0.5	6.4	0.1	0.9	1.2	1.7	**8.5**	**11.4**
Portugal	0.4	0.5	0.8	2.6	0.1	0.4	0.5	0.7	**4.8**	**5.9**
Romania	0.2	0.2	0.2	2.0	0.0	0.2	0.2	0.4	**2.9**	**3.5**
Slovakia	0.0	0.1	0.2	1.1	0.0	0.1	0.3	0.1	**1.6**	**2.0**
Slovenia	0.0	0.1	0.3	1.0	0.0	0.1	0.2	0.2	**1.6**	**2.0**
Spain	0.3	2.8	1.6	11.7	0.1	2.0	2.3	3.8	**18.5**	**24.7**
Sweden	-	1.3	0.3	5.2	-	0.9	1.7	1.0	**7.7**	**10.4**
UK	-	5.1	0.4	31.3	-	4.3	4.9	4.1	**41.1**	**50.1**
EU27	0.5	1.8	1.7	3.8	1.9	0.6	1.5	0.9	**285**	**363**

Annex D Average tax/charge revenue

This annex presents the average revenue from taxes and charges expressed in € per 1,000 vehicle kilometres for passenger cars (Figure 49), motorcycles (Figure 50), busses (Figure 51) and HGVs (Figure 52). In Section 2.5 the average revenue for these vehicle types expressed in € per 1,000 passenger kilometres or € per 1,000 tonne kilometres are presented. Any differences in the 'ranking' of countries in both types of graphs are caused by differences in average occupancy rates (passenger cars, motorcycles and busses) or loads (HGVs) between countries.

Figure 49 Average revenue from taxes and charges for passenger cars in 2013

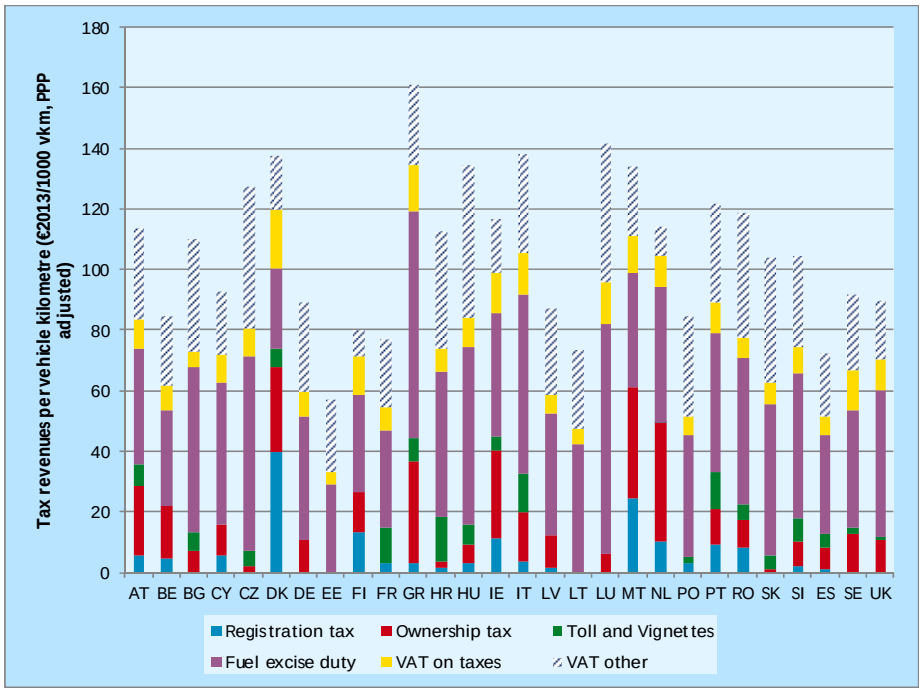


Figure 50 Average revenue from taxes and charges for motorcycles in 2013

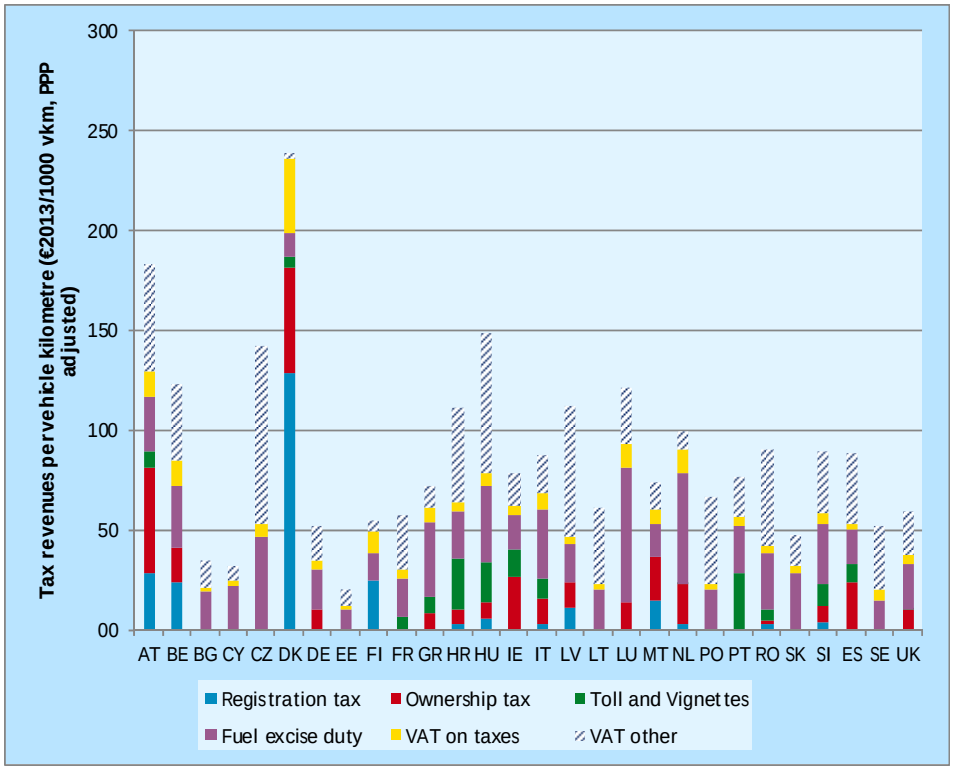


Figure 51 Average revenue from taxes and charges for busses in 2013

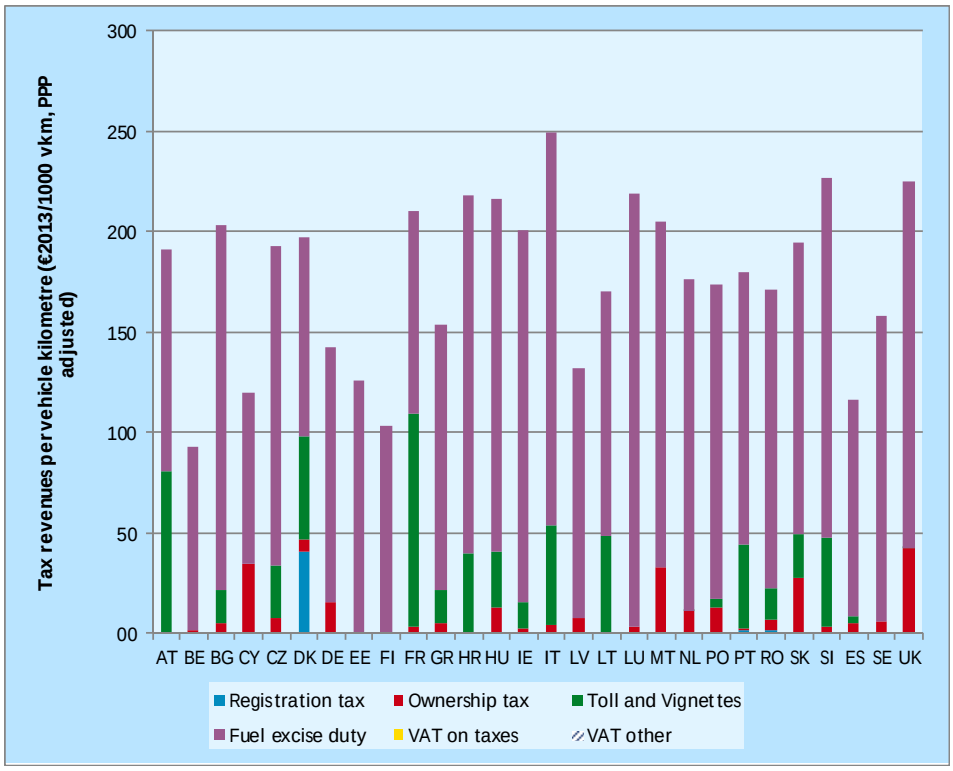
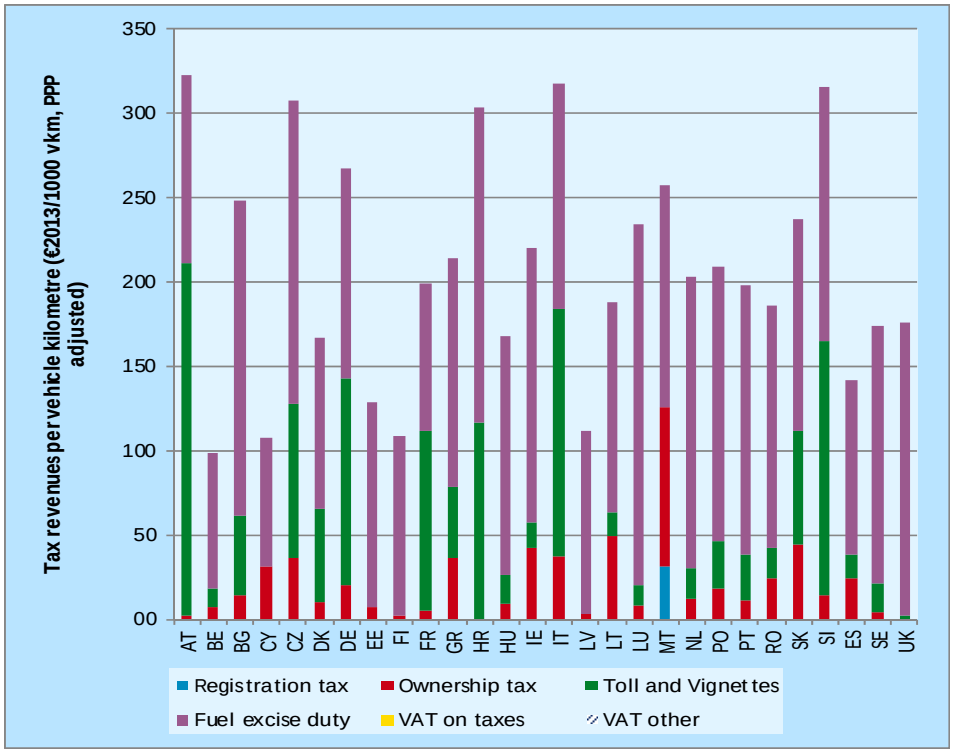


Figure 52 Average revenue from taxes and charges for HGVs in 2013



Annex E Infrastructure expenditures not adjusted for PPP

The PPP adjusted investments, O&M expenditures and total road infrastructure expenditures are presented in Table 5 (Section 3.3), Table 6 (Section 3.4) and Table 7 (Section 3.5), respectively. The figures unadjusted for PPP can be found in Table 24, Table 25 and Table 26.

Table 24 Total investments in road infrastructure (mln €$_{2013}$)

Member State	Long-term (1995-2013) average annual investments	Investments in 2013	Ratio 2013 investments/long term average annual investments
Austria	2,365	1,970	83%
Belgium	1,536	1,432	93%
Bulgaria	273	380	139%
Czech Republic	1,597	897	56%
Denmark	1,163	1,047	90%
Germany	13,516	12,379	92%
Estonia	128	120	94%
Finland	909	1,115	123%
France	13,805	11,961	87%
Greece	1,591	921	58%
Croatia	718	450	63%
Hungary	692	401	58%
Ireland	1,017	561	55%
Italy	7,157	2,663	37%
Latvia	161	150	93%
Lithuania	274	253	92%
Luxembourg	199	220	110%
Malta	24	38	159%
The Netherlands	5,340	5,400	101%
Poland	3,180	2,931	92%
Portugal	1,609	213	13%
Romania	2,343	3,061	131%
Slovakia	493	360	73%
Slovenia	444	104	23%
Spain	6,889	2,926	42%
Sweden	1,943	2,469	127%
United Kingdom	6,075	6,166	102%
EU27	75,439	60,588	78%

Note: As no reliable data on Cypriot road infrastructure investments was available, Cyprus is not shown in this table.

Table 25 Total O&M expenditures on road infrastructure (mln €$_{2013}$)

Member State	Long-term (1995-2013) average annual O&M expenditures	O&M expenditures in 2013	Ratio 2013 O&M expenditures/long term average annual O&M expenditures
Austria	3,357	2,527	75%
Belgium	1,008	1,020	101%
Bulgaria	131	153	117%
Czech Republic	744	695	93%
Denmark	1,245	920	74%
Germany	7,206	9,118	127%
Estonia	100	109	109%
Finland	1,531	1,064	69%
France	7,986	8,300	104%
Greece	321	243	76%
Croatia	312	319	102%
Hungary	897	800	89%
Ireland	202	235	116%
Italy	9,514	4,499	47%
Latvia	113	143	127%
Lithuania	207	182	88%
Luxembourg	67	75	111%
Malta	6	4	60%
The Netherlands	1,808	1,525	84%
Poland	605	548	91%
Romania	422	319	76%
Portugal	1,088	1,059	97%
Slovakia	225	291	129%
Slovenia	184	176	95%
Spain	2,922	2,197	75%
Sweden	1,799	2,360	131%
United Kingdom	4,890	3,346	68%
EU27	48,889	42,226	83%

Note: As no reliable data on Cypriot road infrastructure investments was available, Cyprus is not shown in this table.

Table 26 Total expenditures on road infrastructure (mln €$_{2013}$)

Member State	Long-term (1995-2013) average annual expenditures	Expenditures in 2013	Ratio 2013 expenditures/long term average annual expenditures
Austria	5,722	4,497	79%
Belgium	2,544	2,452	96%
Bulgaria	403	532	132%
Czech Republic	2,341	1,592	68%
Denmark	2,407	1,967	82%
Germany	20,721	21,497	104%
Estonia	228	229	101%
Finland	2,440	2,179	89%
France	21,791	20,261	93%
Greece	1,912	1,164	61%

Member State	Long-term (1995-2013) average annual expenditures	Expenditures in 2013	Ratio 2013 expenditures/long term average annual expenditures
Croatia	1,030	769	75%
Hungary	1,589	1,201	76%
Ireland	1,219	796	65%
Italy	16,670	7,162	43%
Latvia	274	293	107%
Lithuania	481	435	90%
Luxembourg	267	295	111%
Malta	30	42	138%
The Netherlands	7,148	6,925	97%
Poland	3,784	3,479	92%
Portugal	2,031	532	26%
Romania	3,431	4,120	120%
Slovakia	718	651	91%
Slovenia	628	280	45%
Spain	9,811	5,123	52%
Sweden	3,743	4,829	129%
United Kingdom	10,964	9,513	87%
EU27	124,329	102,814	80%

Note: As no reliable data on Cypriot road infrastructure investments was available, Cyprus is not shown in this table.

Annex F Development of expenditures in the EU Member States

F.1 Introduction

In this annex we present the development of infrastructure expenditures in the period 1995-2013 in the individual countries. The development of total expenditures are presented in Section F.2 (investment indices) and Section F.3 (O&M expenditure indices), while the development of the share of these expenditures in GDP are shown in Sections F.4 and F.5, respectively.

To present the results in a clear way, we grouped them for six groups of countries:

- Scandinavian countries: Denmark, Finland, Sweden;
- North Western European countries: Austria, Belgium, Germany, France, Luxembourg, the Netherlands, UK;
- PIIGS: Portugal, Ireland, Italy, Greece, Spain;
- Baltic countries: Estonia, Latvia, Lithuania;
- Other countries that accessed the EU in 2004: Czech Republic, Hungary, Malta, Poland, Slovakia, Slovenia;
- Countries that recently accessed the EU: Bulgaria, Croatia and Romania.

The graphs presented in this Annex are meant to assess the developments over time of road expenditures in the individual EU countries. These graphs do not have the objective of comparing/benchmarking the various countries[38].

The data sources used to estimate the developments of road infrastructure expenditures over time as well as the main uncertainties associated to these data are discussed in Annex A.

[38] As discussed in Section 1.4 countries may differ in accounting principles applied and in the quality and availability of the data, which may hamper the comparison of expenditure data between countries.

F.2 Investment indices

The investment indices for the various EU countries are presented in Figure 53 to Figure 58. All indices are based on annual figures expressed in euros price level 2013 and PPP adjusted.

Figure 53 Investment indices for road infrastructure in the period 1995-2013 in Scandinavian countries

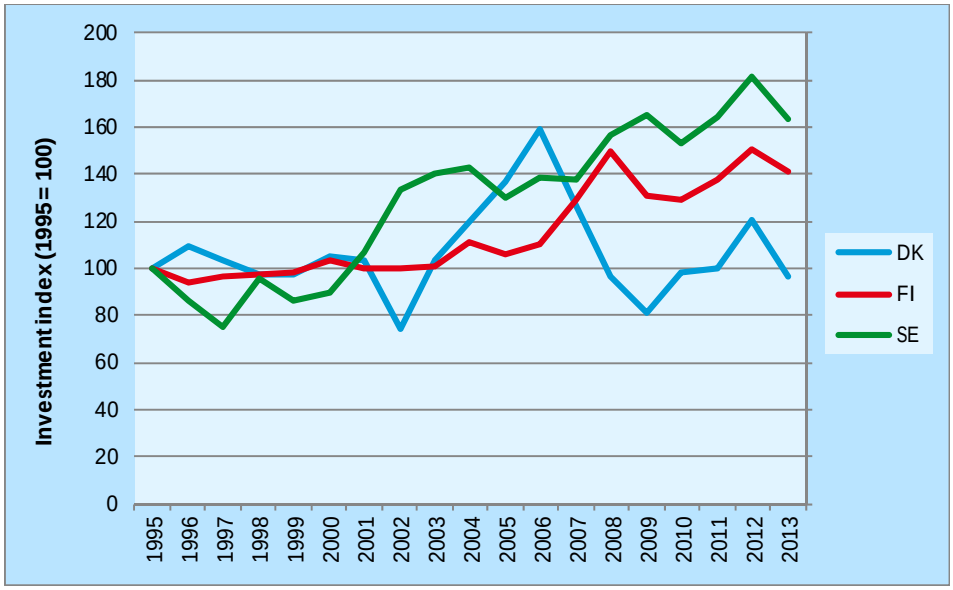


Figure 54 Investment indices for road infrastructure in the period 1995-2013 in North Western European countries

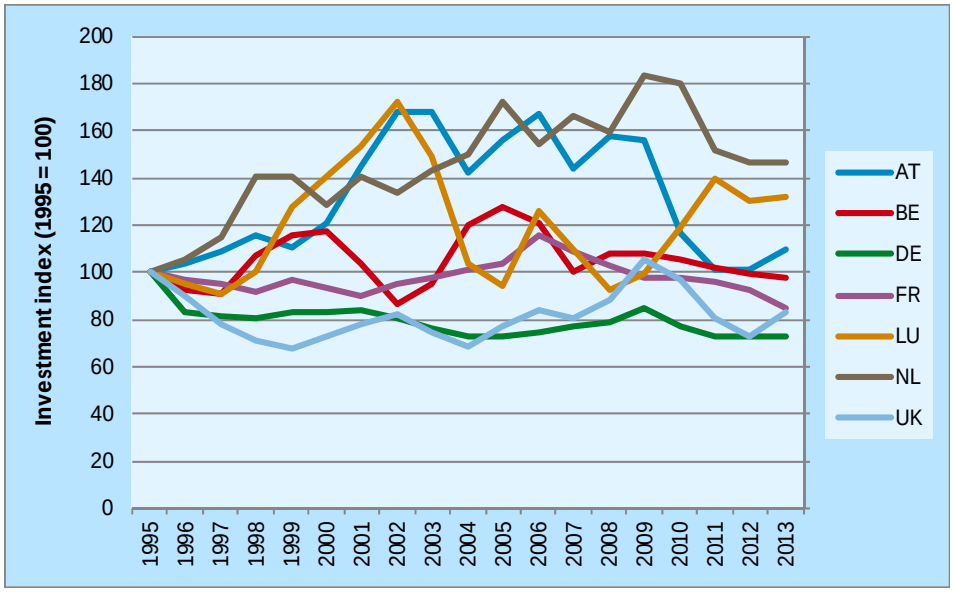


Figure 55 Investment indices for road infrastructure in the period 1995-2013 in PIIGS

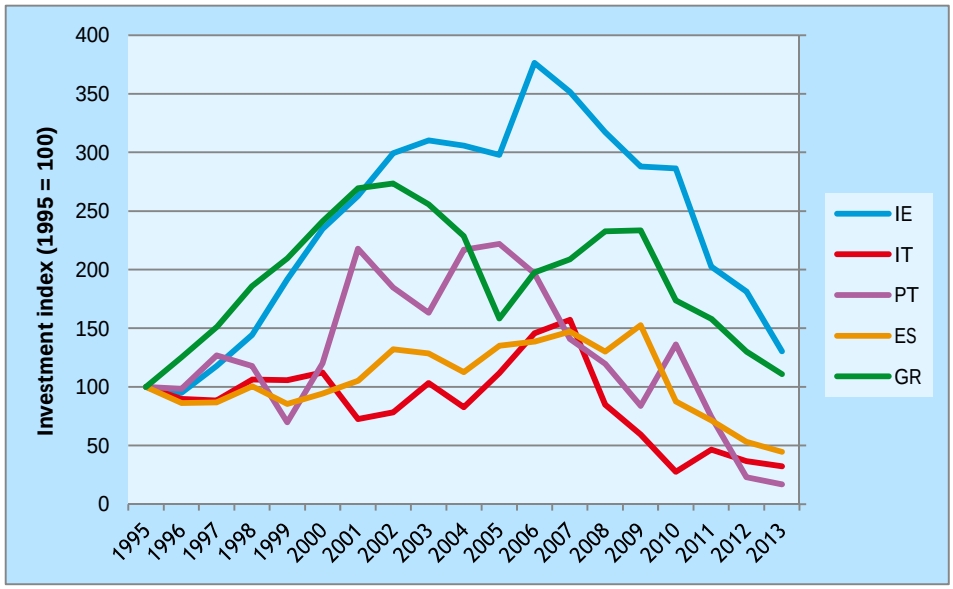
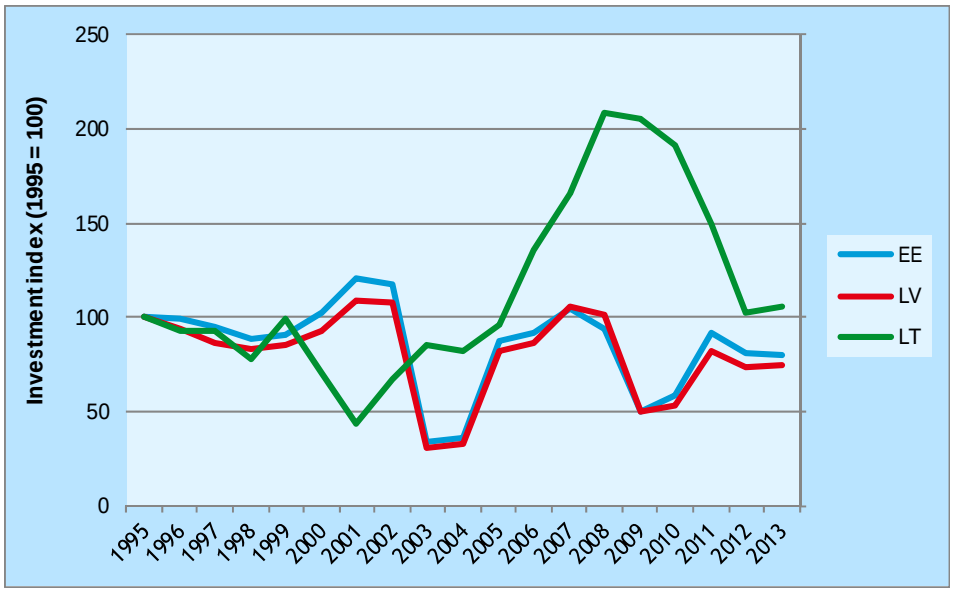


Figure 56 Investment indices for road infrastructure in the period 1995-2013 in Baltic countries



Note: As the investments in Estonia are estimated based on the investments per kilometre road in Latvia, the development over time is almost the same in both countries (see Annex A.4).

Figure 57 Investment indices for road infrastructure in the period 1995-2013 in the other countries that accessed the EU in 2004

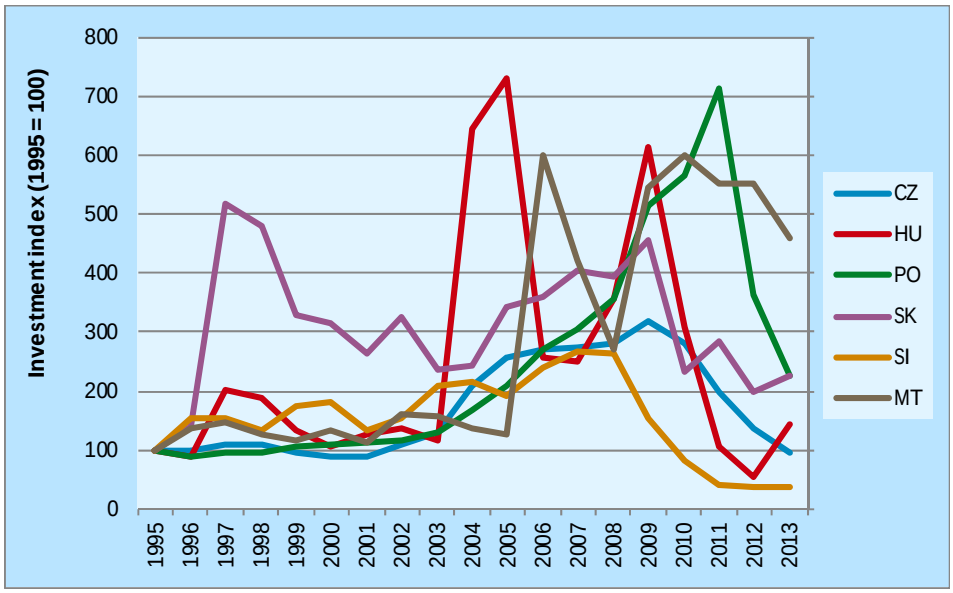
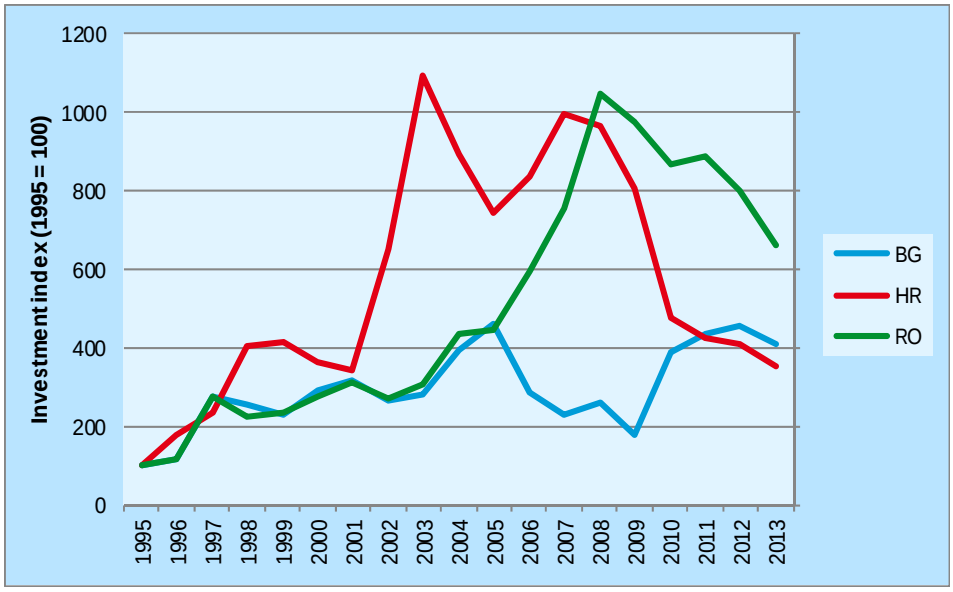


Figure 58 Investment indices for road infrastructure in the period 1995-2013 in the countries that recently accessed the EU



Note: As the investments over the period 1995-2005 in Bulgaria and Romania are estimated using the same growth trend, the development in these expenditures over that period shows the same pattern for both countries (see Annex A.4).

F.3 O&M expenditure indices

The O&M expenditure indices for the various EU countries are presented in Figure 59 to Figure 64. All indices are based on annual figures expressed in Euros price level 2013 and PPP adjusted.

Figure 59 O&M expenditure indices for road infrastructure in the period 1995-2013 in Scandinavian countries

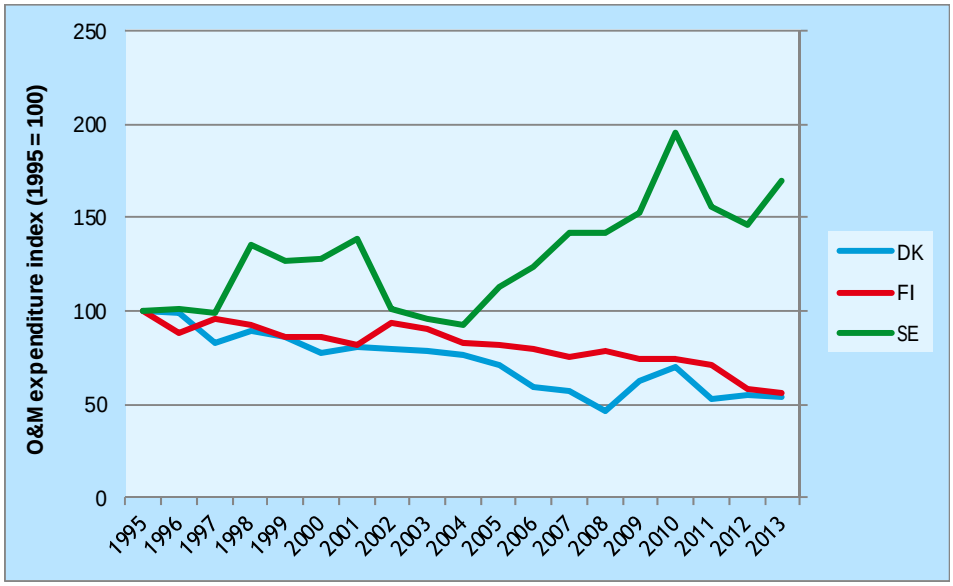


Figure 60 O&M expenditure indices for road infrastructure in the period 1995-2013 in North Western European countries

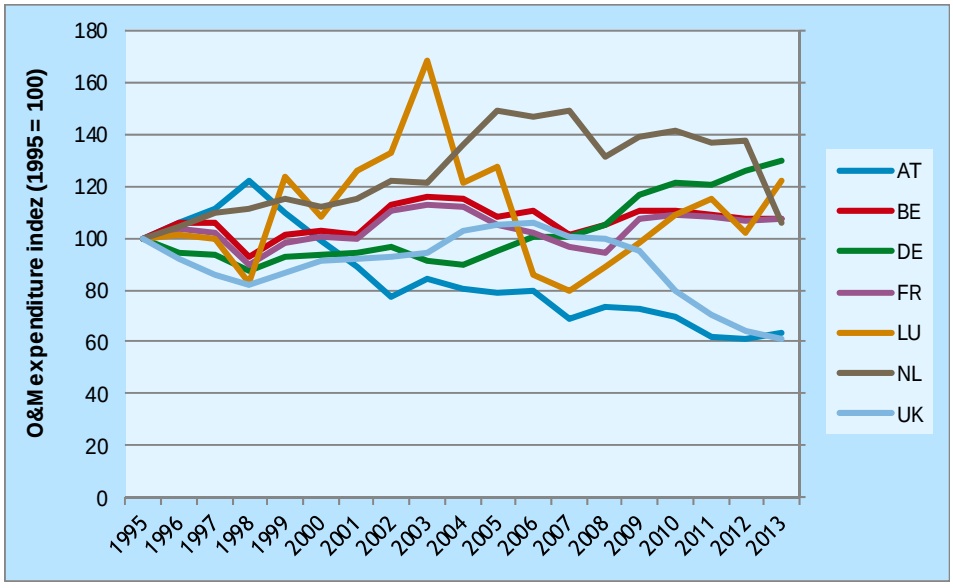
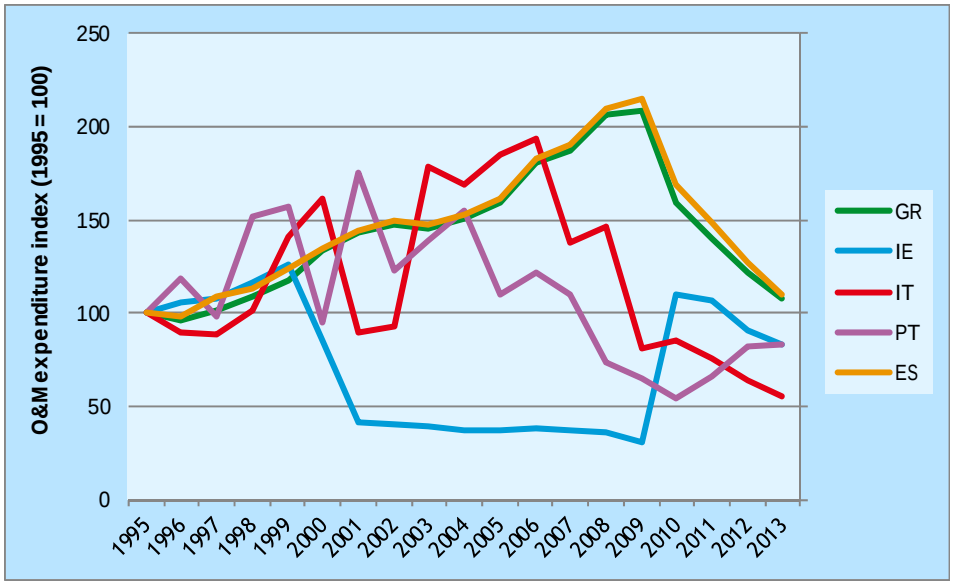
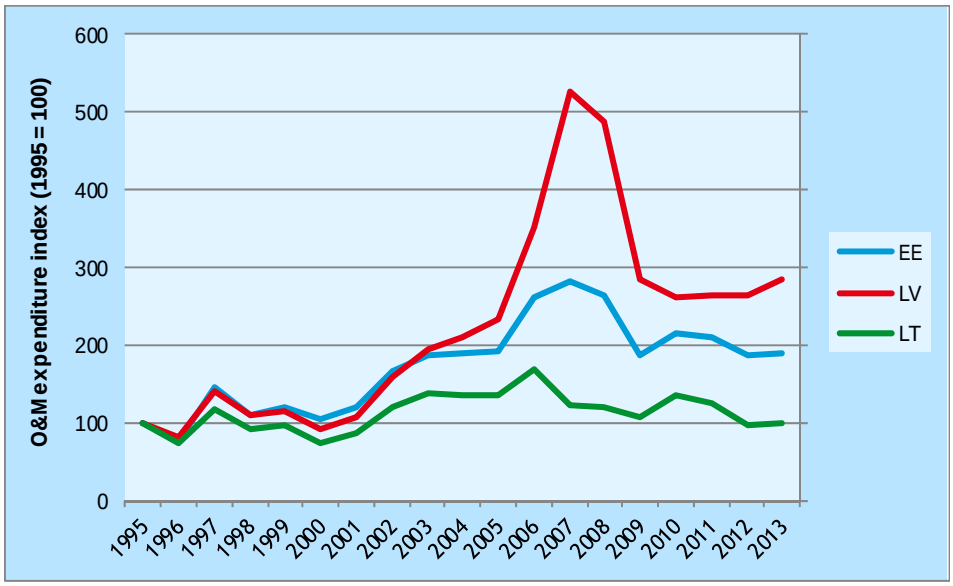


Figure 61 O&M expenditure indices for road infrastructure in the period 1995-2013 in PIIGS



Note: As the same growth rate is used to estimate the O&M expenditures over the period 1995-2013 in Greece and Spain, the development in these expenditures over that period shows the same pattern for both countries (see Annex A.5).

Figure 62 O&M expenditure indices for road infrastructure in the period 1995-2013 in Baltic countries



Note: As the same growth rate is used to estimate the O&M expenditures over the period 1995-2001 in Estonia, Latvia and Lithuania, the development in these expenditures over that period shows the same pattern for the three countries (see Annex A.5)

Figure 63 **O&M expenditure indices for road infrastructure in the period 1995-2013 in the other countries that accessed the EU in 2004**

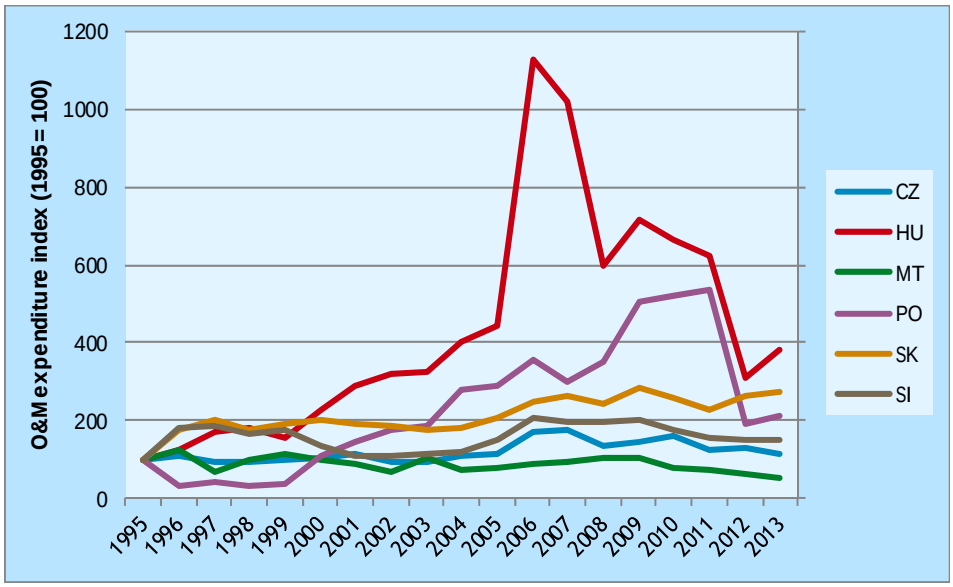
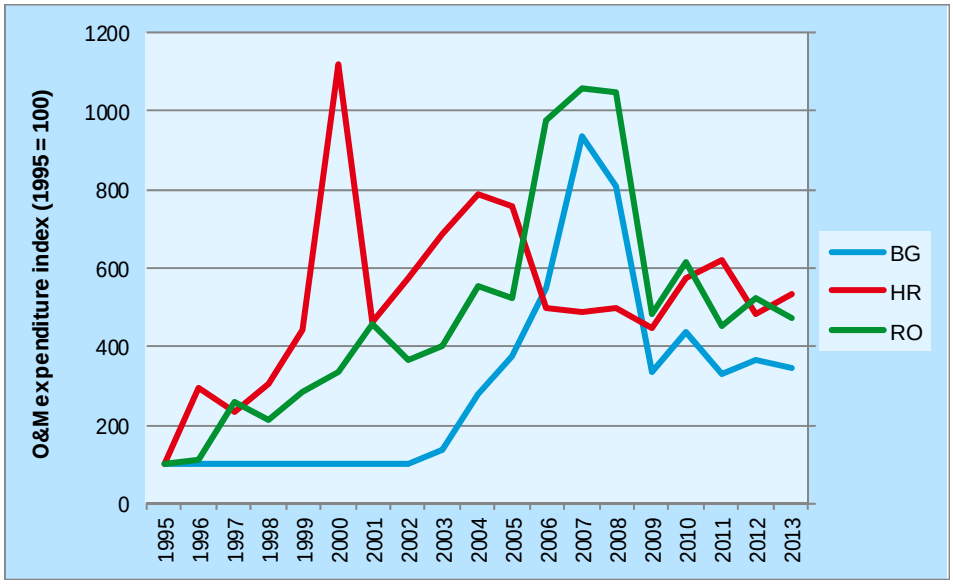


Figure 64 **O&M expenditure indices for road infrastructure in the period 1995-2013 in the countries that recently accessed the EU**



Note: As the O&M expenditures over the period 2006-2013 in Bulgaria and Romania are estimated using the same growth trend, the development in these expenditures over that period shows the same pattern for both countries (see Annex A.5). For Bulgaria it was not possible to provide significantly reliable O&M expenditure figures for the period 1995-2002 and hence the figures were kept constant.

F.4 Investments as share of GDP

The development of investments as share of GDP in the various EU countries is presented in Figure 65 to Figure 70.

Figure 65 Investments as share of GDP in the period 1995-2013 in Scandinavian countries

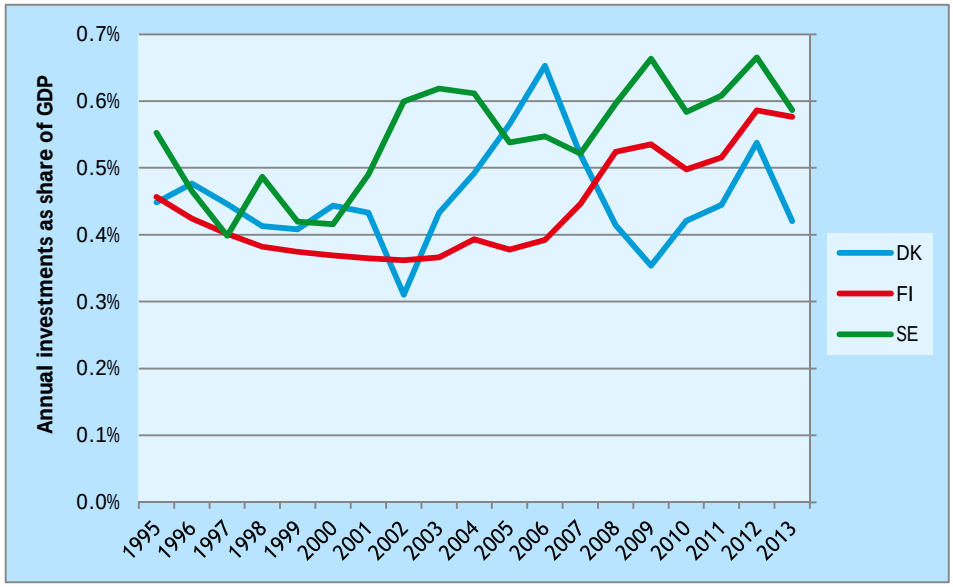


Figure 66 Investments as share of GDP in the period 1995-2013 in North Western European countries

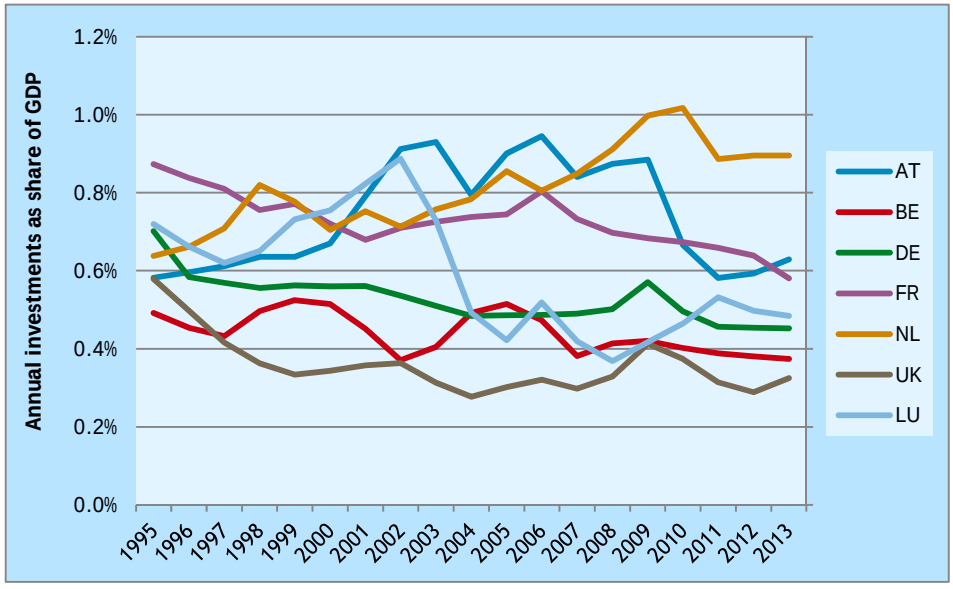


Figure 67 Investments as share of GDP in the period 1995-2013 in PIIGS

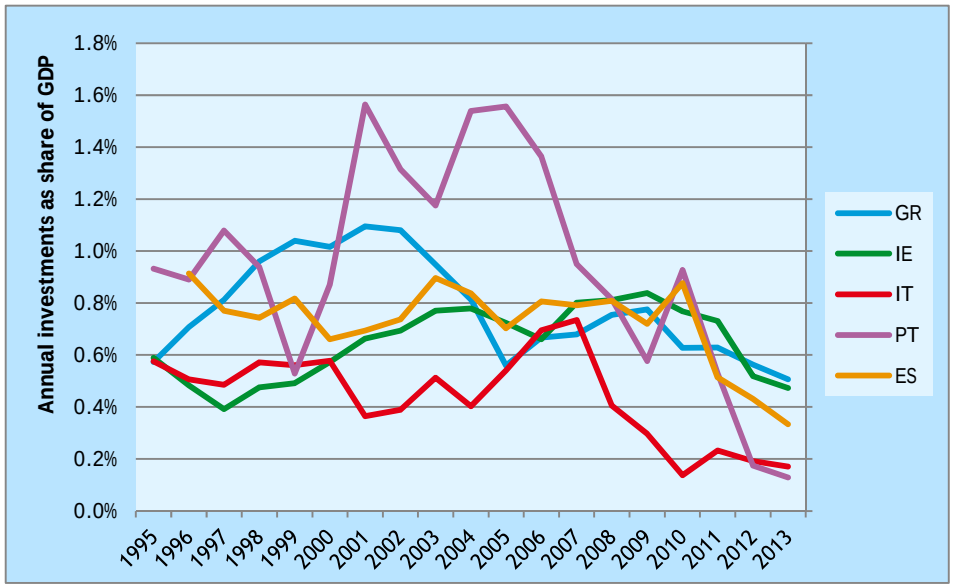


Figure 68 Investments as share of GDP in the period 1995-2013 in Baltic countries

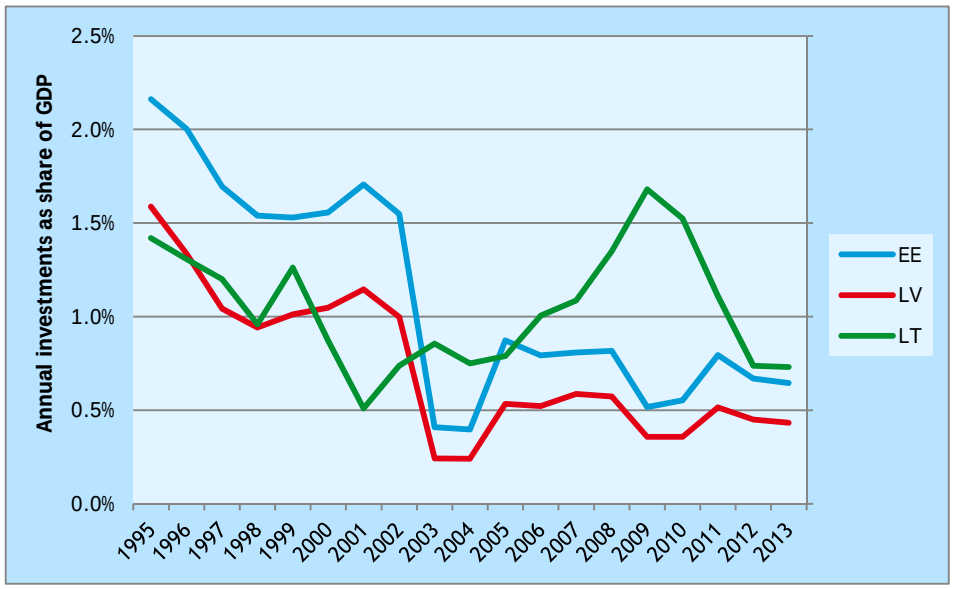


Figure 69 **Investments as share of GDP in the period 1995-2013 in other countries that accessed the EU in 2004**

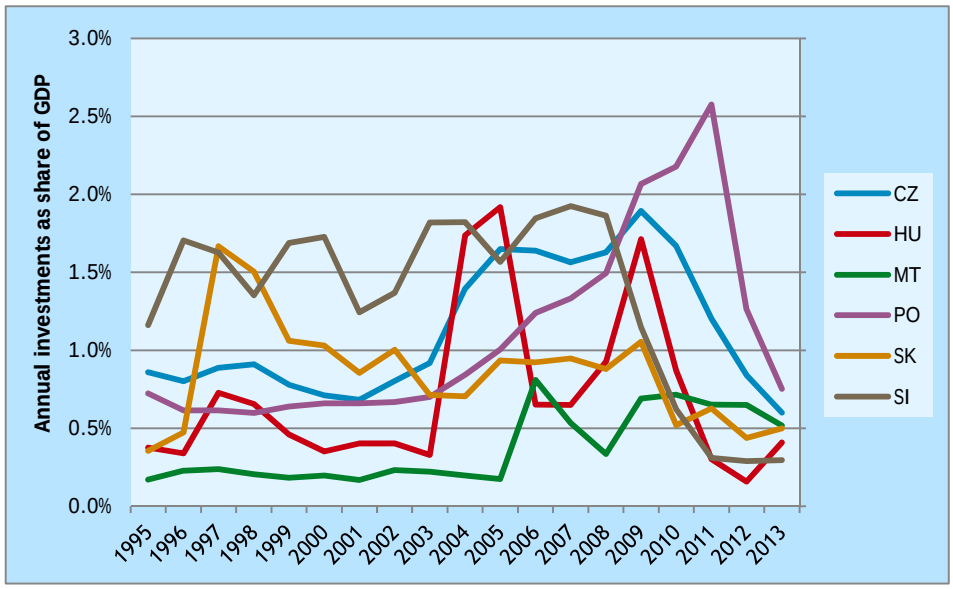
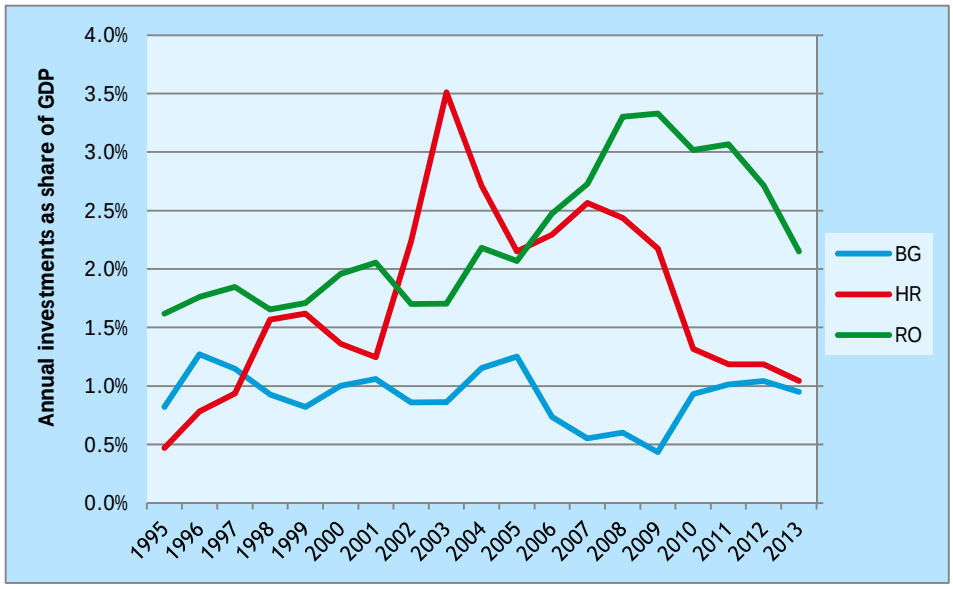


Figure 70 **Investments as share of GDP in the period 1995-2013 in countries that recently accessed the EU**



F.5 O&M expenditures as share of GDP

The development of O&M expenditures as share of GDP in the various EU countries is presented in Figure 71 to Figure 76.

Figure 71 O&M expenditures as share of GDP in the period 1995-2013 in Scandinavian countries

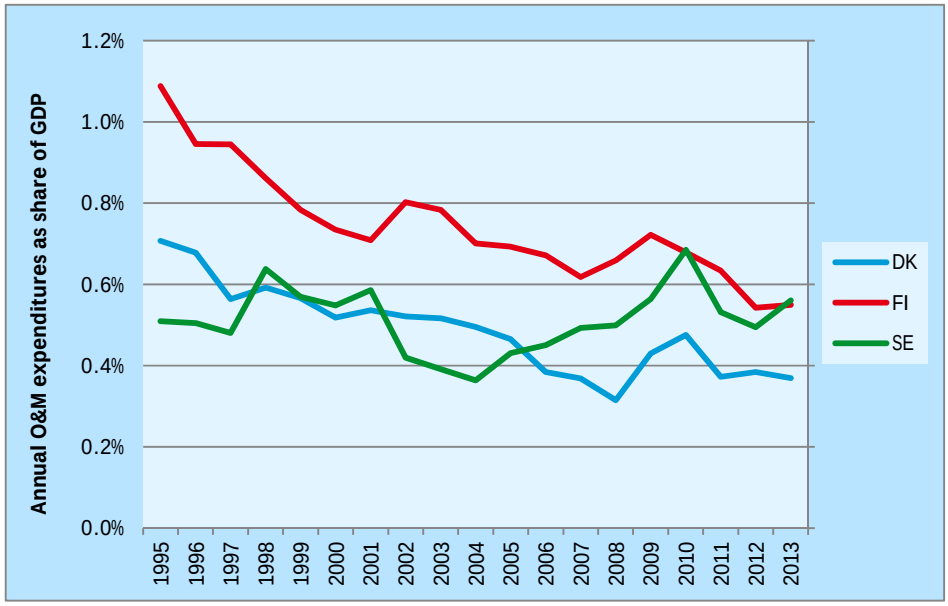


Figure 72 O&M expenditures as share of GDP in the period 1995-2013 in North Western European countries

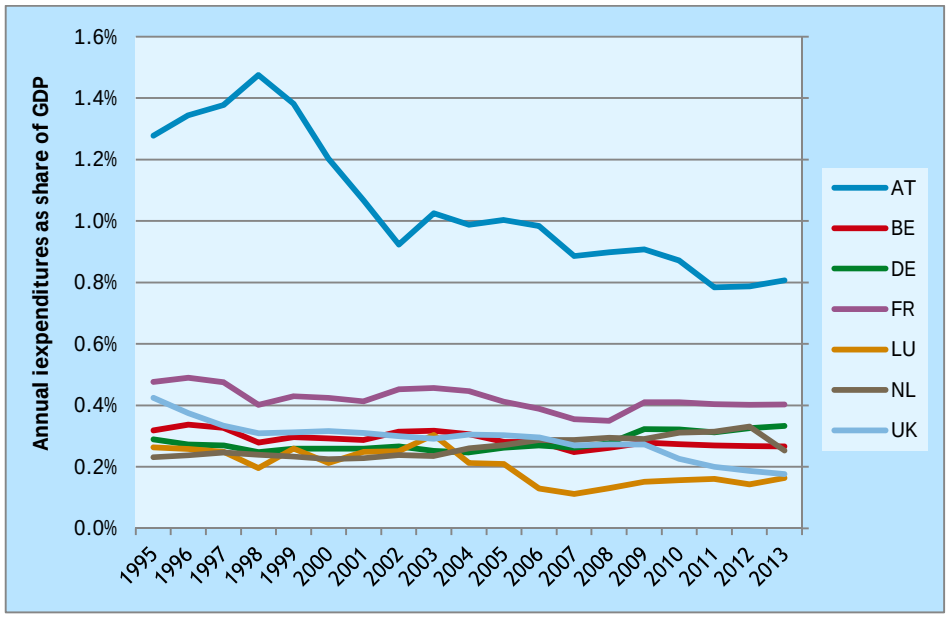


Figure 73 O&M expenditures as share of GDP in the period 1995-2013 in PIIGS

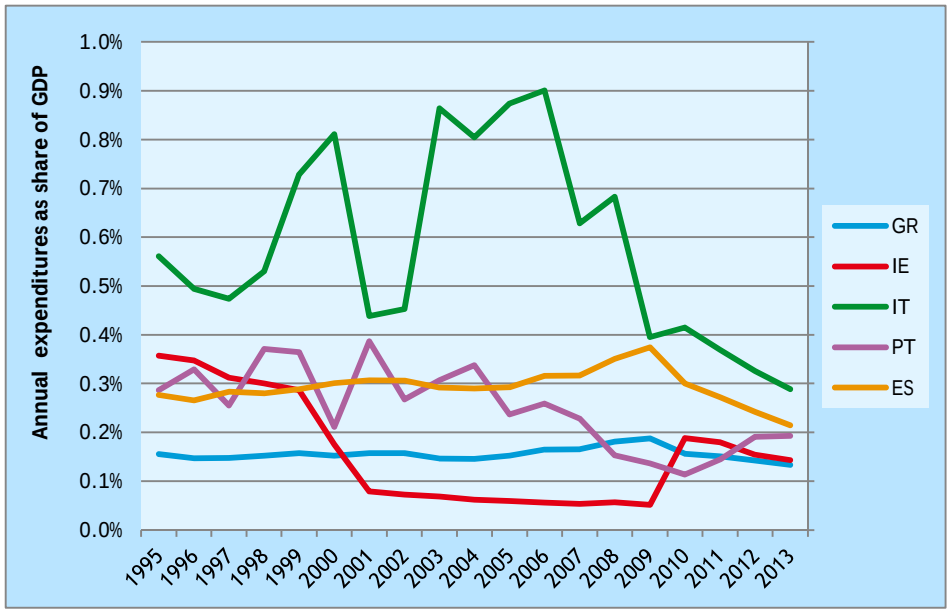


Figure 74 O&M expenditures as share of GDP in the period 1995-2013 in Baltic countries

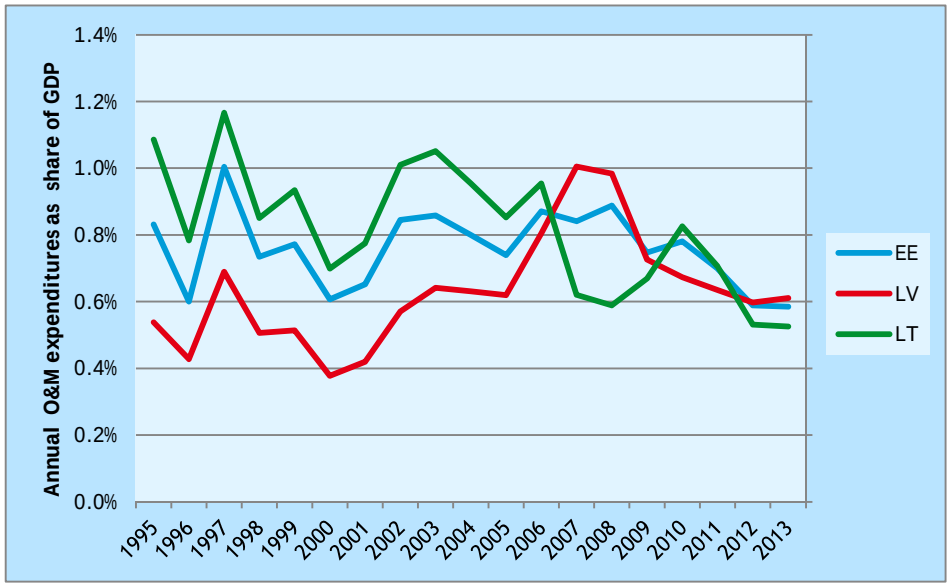


Figure 75 **O&M expenditures as share of GDP in the period 1995-2013 in other countries that accessed the EU in 2004**

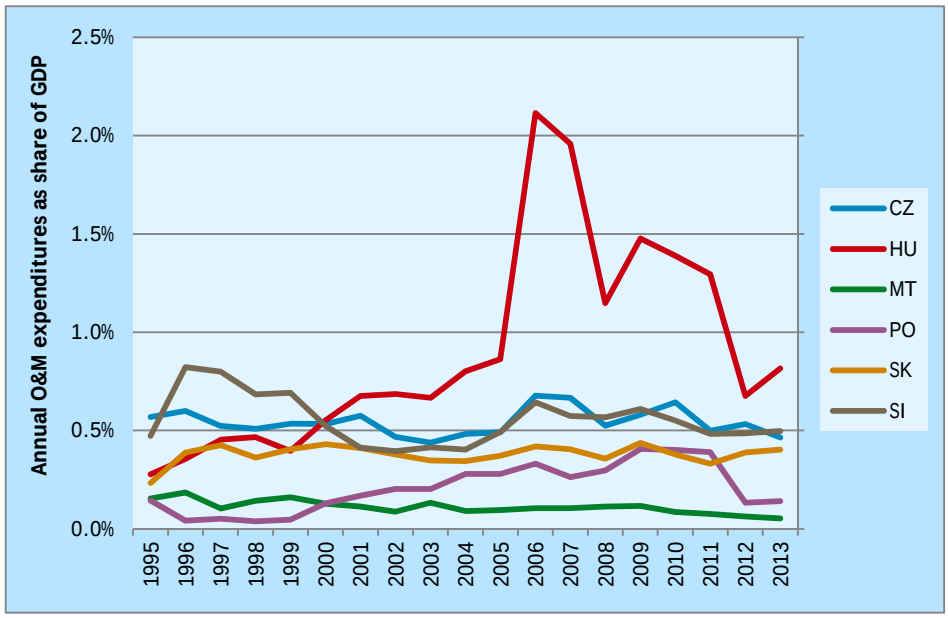
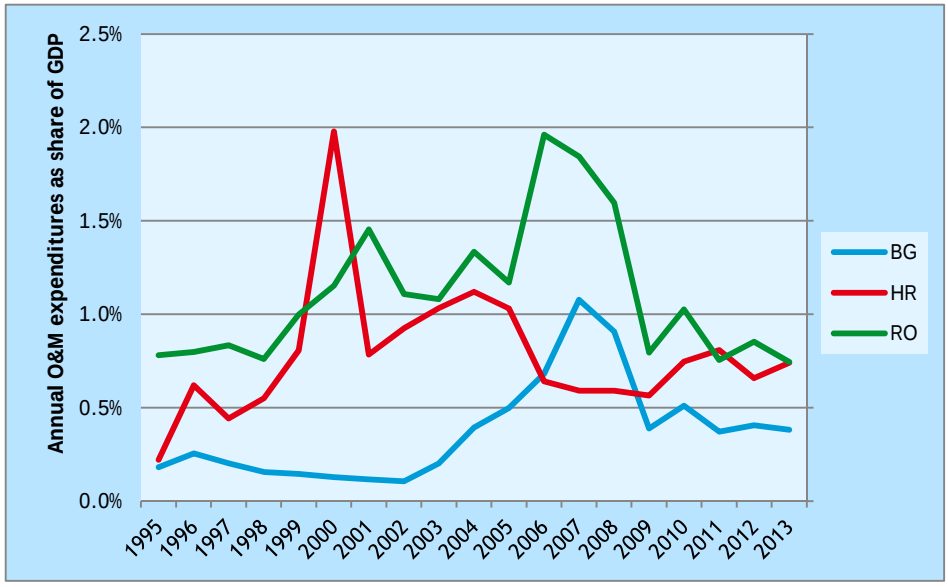


Figure 76 **O&M expenditures as share of GDP in the period 1995-2013 in countries that recently accessed the EU**



Annex G Allocation of infrastructure costs

In CE Delft and VU (2014), a literature review on the allocation of infrastructure costs of road transport was carried out. Five international studies estimating the infrastructure costs of road transport for a specific country (i.e. Switzerland, The Netherlands, Great Britain, Germany and Australia) and two studies providing a (qualitative) meta-analysis on this issue (i.e. (Fraunhofer-ISI ; CE Delft, 2008) and (HLG, 1999) were reviewed. The main results of the review of these studies are summarised in Table 27.

Based on this literature review we conclude the following:

- Almost all studies distinguish between capacity and weight related *enhancement costs*. In general, about 90% of the enhancement costs are considered capacity related and 10% weight related (an exception is NTC (2005) which assumes that just 45% of the enhancement costs in Australia are weight related). In this study we use the same shares of capacity and weight related enhancement costs. As CE Delft (2008) and ITS (2001) we allocate the capacity related enhancement costs based on Passenger Car Equivalent (PCE) kilometres and the weight related enhancement costs based on axle load kilometres (4^{th} power rule).
- Different approaches are used to allocate the *renewal costs* of road infrastructure. However, all studies distinguish between capacity related and weight related renewal costs. Based on the results from the various studies and detailed data for the Netherlands (not shown in Table 27, but presented in CE Delft (2008)) we assume that ca. 60% of the renewal costs are weight related and ca. 40% are capacity related. As for enhancement costs, the capacity related costs are allocated based on PCE-kilometres and the weight related costs on axle load kilometres (4^{th} power rule).
- With respect to the allocation of maintenance costs, most studies distinguish between fixed and variable costs. Since the variable maintenance costs are – at least partly weight dependent – we allocate these costs based on axle load kilometres. With respect to the fixed maintenance costs almost all studies agree that these costs depend both on weight and capacity factors. However, different kind of approaches are used. In this study we apply the German approach (which was also used by CE Delft (2008) and CE Delft and VU (2014) for the Netherlands), implying that 50% of the costs are allocated based on PCE-km, 35% based on vehicle kilometres and 15% are allocated to heavy goods vehicles.
- Both vehicle kilometres and PCE-kilometres (or a combination of both) are used as cost drivers to allocate the *operational costs* of road transport. In this study we apply the German approach (30% of the operational costs are allocated based on vehicle-kilometres, 70% based on PCE-kilometres).

Table 27 Main results of literature review on allocation approaches applied in infrastructure costs studies

Source	Country	Enhancement costs	Renewal costs	Maintenance costs	Operational costs
BSF (2003)	Switzerland	– 95% capacity related: 80% allocated based on PCE-km, 20% allocated based on vkm – 5% weight related: fully allocated to HDVs (> 3.5t) based on standard axle load kilometres	– 55% capacity related: 80% allocated based on PCE-km, 20% allocated based on vkm – 45% weight related: fully allocated to HDVs (>3.5t) based on axle load vehicle kilometres	– 100% allocated based on vkm	– 100% allocated based on vkm
CE Delft (2008)	The Netherlands	– 89% capacity related: allocated based on PCE-km – 11% weight related: allocated based on standard axle load kilometres	– Fixed costs: 35% allocated based on vkm, 50% on PCE-km and 15% are fully allocated to HGVs (>12t) – Variable costs: mainly allocated based on standard axle load km	– Fixed costs: 35% allocated based on vkm, 50% on PCE-km and 15% are fully allocated to HGVs (>12t) – Variable costs: mainly allocated based on standard axle load km	– Ca. 44% are allocated based on vkm, 14% based on standard axle load km and 41% based on PCE-km
ITS (2001)	UK	– 85% capacity related: allocated based on PCE-km – 15% weight related: allocated based on standard axle load km	– Detailed approach – Renewal costs are mainly allocated based on standard axle load kilometres	– Detailed approach – Variable costs are mainly allocated based on standard axle km – Fixed costs are mainly allocated based on PCE-km and/or average gross vehicle weight km	– Operational costs are mainly allocated based on PCE-km (a minor part is allocated based on average gross tonne km)
ProgTrans (2007)	Germany	– Very detailed approach – Main part of cost elements is allocated based on PCE-km – Smaller part of costs is allocated fully to specific vehicle categories (mainly HGVs)	– Very detailed approach – According to IMPACT D2 about 50% are allocated based on PCE-km, 22% on vkm and 28% on standard axle load km	– Fixed costs: 35% allocated based on vkm, 50% on PCE-km and 15% are fully allocated to HGVs (>12t) – Variable costs: allocated based on PCE-km, axle load km and vkm. A part of the costs is allocated to specific vehicle categories	– 30% allocated based on vkm – 70% allocated based on PCE-km
NTC (2005)	Australia	– 45% weight related: allocated based on standard axle load – 55% not attributable: allocated based on vkm	– 45% weight related: allocated based on standard axle load – 55% not attributable: allocated based on vkm	– Detailed approach – Allocated based on axle load km, PCE-km and vkm	– 100% allocated based on vkm
Fraunhofer-ISI and CE Delft (2008)	EU	– 100% allocated based on PCE-km	– 80% allocated based on PCE-km – 10% allocated based on vkm – 10% allocated based on standard axle load km	– 100% based on standard axle load km	– 100% allocated based on vkm
High level group (1999)	EU		– Costs should be allocated based on axle weight, gross vehicle weight and/or PCE-km	– Cost should be allocated based on axle weights	– Cost should be allocated based on vkm or PCE-km